THE

ELECTRICAL REVIEW.

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THE ELECTRICAL REGULATIONS OF THE HOME OFFICE.

THAT human life is sacred and must be protected at all costs is universally admitted, but if those engaged in dangerous trades were only reasonably careful, half the regulations and precautions instituted for their protection would be unnecessary.

As long as colliers continue to open the safety lamps provided for their protection, stokers to weight safety valves of boilers, people to search for gas leaks with naked lights and generally perform the thousand and one stupid acts which are continually being reported, no amount of restrictive legislation will prevent the distressing loss of life now so common. While we are obliged to admit that in many cases accidents have occurred through the lack of proper means for the safeguarding of employés, a large number have been due to the carelessness of the individual in disobeying rules or wilfully neglecting to use those appliances provided for his protection.

The Report of the Departmental Committee is a highly creditable production, and bears undoubted evidence of exhaustive enquiry and careful deliberation. We heartily sympathise with the object of the Report, but we must also extend our sympathy to the unfortunate engineers of all high tension stations. What with the Electric Lighting Act and Provisional Order, the Notice of Accidents Act, the Board of Trade Regulations, and now the Home Office Regulations, to say nothing of the censorship of the County Council and the coming Employers' Liability Act, they are in danger of a bad attack of mental indigestion.

Seriously speaking their position is becoming most onerous.

The Report proper calls for little remark. *Clause* 3 contains a statement that "broadly speaking the accidents which have occurred are those which are most likely to occur," and on reference to Appendix I. we think the remark is quite justified.

In the same Clause it is stated as the opinion of the Committee "that the dangers from electric shock in the generation and distribution of high pressure currents can never be entirely obviated." This is evident from the fact that it is impossible to protect an employé against the results of his own carelessness and neglect.

In *Clause* 4 the Committee are careful to point out that they disclaim "for their proposals any element of finality." While certain additions or modifications will doubtless be required at some future time, we hope for the sake of the

industry that such alterations will not be found frequently necessary, particularly if the rules are to be retrospective.

It may be true, as stated in the latter part of this Clause 4, "that the occupiers and employers . . . . will be grateful for the relief from responsibility which their (the regulations) acceptance and execution will accord," because the employers, by the expenditure of a little extra capital, throw the whole responsibility upon their chief officials.

Clause 5 gives the names of those gentlemen who have assisted the Committee with their technical advice, and while the list is a fairly representative one, we should have liked to see more of the central station engineer element, when we think the Committee would have modified some of its recommendations.

Clauses 6 *to* 16 inclusive are descriptive of the various systems and the methods of working.

Clauses 17 *to* 27 inclusive describe the risks attendant upon the use of high tension electricity.

The latter part of *Clause* 27 refers to methods of resuscitation in case of apparent death from electric shock, and we thoroughly agree with the Committee when they say that "it is desirable not only that workers in electrical generating and distributing stations should be made thoroughly cognisant of the dangers incidental to their calling, but should receive practical instruction in methods of treating suspended animation," and we think, judging by the large number of copies of the Electrical Review's suggestions for dealing with apparent death from electric shock which we have supplied to central stations, that the engineers are also completely in accord.

Appendix I. details 14 cases of death during the past five years, and while, under all the circumstances, the list is comparatively small, it is quite sufficient to justify the action of the Home Office in appointing a committee of investigation, and in placing high tension stations under reasonable control.

In looking down the list, it will be found that there is not a single case in which accident might not have been prevented had reasonable precautions been observed by the victim himself, or had proper protection against contact been provided.

In articles which appeared in our issues of November 29th, 1895, and February 14th, 1896, on the new Board of Trade Regulations, we called attention to the fact that, in the definition of high pressure, an invidious distinction had been made between alternating and continuous currents, although there was no valid reason why such a distinction should be made.

The same error appears in *Clause* 28 of the official report.

In this case, however, the Committee evidently hold that neither direct nor alternating currents are as deadly as the Board of Trade believe, for they have raised the limit by 200 volts in the case of direct currents, and 100 volts in the case of alternating currents, over that provided in the Board of Trade Regulations, the pressures being 700 and 350 volts respectively.

We again raise our protest against this most unfair distinction, for which there does not appear to be any justification, and we should be interested to know by what method of reasoning the belief in greater danger to life of an alternating current is arrived at.

Section I. of the recommendations provides for earthing the frames and bed-plates of generators, and is a wise precaution, if, at the same time, all conducting parts are rendered inaccessible.

Section II. provides that the rails fencing the generators shall be made of *wood or other insulating material.*

This, we think, is not only unnecessary, but inexpedient, As a mechanical protection to running machinery, metal rails are infinitely superior to wood, as no matter how well seasoned it may be, the high temperature in some engine rooms would inevitably cause shrinkage, and the wood fence would frequently be in a shaky and tumble down condition, and become in itself a source of danger rather than a safeguard.

We presume that accident No. 8 in the Appendix was taken as having supplied a reason for this recommendation. According to the Appendix, however, the fatality occurred while "oiling the bearings of an alternator machine, *the bed of which was earthed.* It is supposed that a short circuit was set up by the oil can." In the absence of further information, we are unable to give an opinion as to the real cause of the accident; but it is possible that a circuit may have been formed between some "live" part of the alternator and earth through the oil can, the man's body, and the floor; or he may have touched the frame of the machine with his other hand or his feet.

In any case if the conducting parts of the alternator had been covered up and the handle of the oil can insulated, a wood fence would be unnecessary.

Section III. requires all high tension conducting parts of apparatus to be properly covered up or fenced, and is quite reasonable, as also is *Section IV.*, in which it is required that insulating mats shall cover the floor wherever uncovered high tension conductors are accessible.

Section V. provides that the wipers used for commutators, &c., shall have insulating handles, and as we presume this applies to high tension dynamo commutators, and to alternators having rotating armatures, it is a very necessary precaution.

Section VI. requires the proper protection of the fronts of switchboards, so that accidental contact is not possible. This is reasonable and proper, as well as *Section VII.*, which deals with the backs of switchboards, provided that "*accidental*" contact is reasonably interpreted, and does not include any stupid action consequent upon absence of mind. An absent-minded electrician or workman in a central station is a danger to himself and everybody around him, no matter what protection is provided.

Section VIII. is a most sensible recommendation, and requires that all new switchboards shall have a space of at least four feet clear behind, and shall not be obstructed.

To cramp the space and so compel men whether they like it or not to stand so near high tension terminals that the least slip would prove fatal whenever they have to go behind the board is little short of criminal.

The use of rubber gloves on both hands is insisted upon in *Section IX.* in case of men working on high pressure mains.

Section X. provides for the proper insulation of aerial conductors in workshops and factories, and both this and Section IX. are reasonable.

Section XI. is as follows:—"The gloves (referring, we presume, to Section IX.) shall be supplied by the occupier

and it shall be the duty of the manager to see that they are in a proper state of repair and are worn by the workpeople."

At first sight this appears to be a harmless and reasonable requirement, but upon further consideration it will be found that as at present worded it would in a large central station be unworkable.

How is it possible for the manager, or chief engineer, to see that the gloves are always worn? It would necessitate his personal superintendence at all times whenever work on the mains was being carried out, and this may be nearly every day.

As the Section now stands a workman may be negligent, disobey orders, and work without gloves, when in case of accident the manager becomes personally responsible and renders himself liable to an indictment for manslaughter because he did not literally obey a regulation which is impracticable.

This may appear to be far fetched, but anyone having experience with juries must know that such a regulation issued by the Home Office would be used as a weapon against the unfortunate manager.

The Section should be altered to read:—"The gloves shall be supplied by the occupier, and it shall be the duty of the manager to enforce their use by the workmen by means of stringent rules, to which the attention of the men shall be frequently called, and they shall be prohibited by a similarly stringent rule from using any gloves that are not in a proper state of repair," or words to this effect.

Proper and reasonable precautions for the protection of workmen are necessary, but to make a manager responsible for the gross carelessness and disobedience to orders of his staff is unreasonable and unjust.

Section XII. prohibits the alteration or repair of "live" parts except in cases of urgent necessity, when it shall be done under the personal supervision of an electrical engineer or competent foreman. This is a wise and necessary recommendation.

Section XIII. provides for the locking of the switch when a main has been switched off for work to be carried out, and it shall not be unlocked "*except by the person in charge of the station, on his being satisfied that the danger is at an end.*"

This assumes apparently that a main must of necessity be disconnected *at the station*, while, as a matter of fact, the Board of Trade Regulations practically necessitate the use of ring or sectional mains, and therefore the man at the station has nothing to do with it, all disconnection being made outside.

Section XIV. requires the use of insulated oil cans for lubricating, and should not cause any inconvenience in carrying out.

Section XV., which requires the permanent earthing of transformer boxes, is one of the most necessary recommendations.

Section XVI. requires that all metal work not forming part of the circuit shall be metallically connected together.

Section XVII. states that "all holes in transformer cases through which high pressure conductors pass, shall be lined or bushed with suitable and effective non-conducting material." This is obviously unnecessary where concentric cables are used, and the outer earthed. The section should be amended to provide for this.

Section XVIII. provides that "all high tension connections within a transformer chamber shall be so protected with insulating material, that it shall be impossible to touch them." Here the word "accidentally" should be added.

Section XIX. is most important, and requires that switches for cutting off both high and low pressure connections of the transformers shall be fixed so that they can be operated outside the chambers. This is intended to be retrospective.

Section XX. requires an isolating switch on all series arc lamp columns and supports. We should suggest earthing such columns in addition.

Section XXI. provides that "all persons engaged in electrical works shall be made fully aware of the dangerous parts of the *machinery, cables, and their connections.*" To this we take strong exception. As it reads, a stoker must be taken around the engine house and switch-room, and have pointed out to him certain parts that he must not touch, and is equivalent to giving him permission to enter a part of the works where he has no business. Obviously the safest thing to do is to prohibit him from entering that part of the works at all in which danger lies, and generally to prohibit unauthorised men going where their duties do not call them. This part of the Section, as it now stands, may be a source of danger instead of a safeguard.

The section continues, "and shall be practically instructed in methods of artificial respiration." A number of the men on each shift should be so instructed, but it is unnecessary that all should be included.

The continuation of the section requiring that rules for artificial respiration shall be affixed in the station is necessary, but "all persons engaged in the works shall thoroughly understand these rules, and be capable of putting them into practice," reminds us of the old proverb about leading a horse to the water. How is it to be enforced, and is the unfortunate manager to be responsible?

Section XXII. requires notice of accidents to be given under Section 18 of the Factory and Workshop Act, 1895.

Clause 29 (and last) recommends that a specially qualified person shall be retained to advise the Secretary of State, or Her Majesty's Chief Inspector of Factories, on matters requiring technical knowledge of electricity, in order that special rules for the safety of workpeople shall perfectly realise their object. This is a very good suggestion, provided that the appointment is a permanent one, and a selection made from men who have had long practical experience in works of this kind, and not simply some individual who has qualified (?) for the position by successfully passing an examination of the usual useless kind.

The report does not state whether or not the rules are to be generally retrospective, but we presume not, or some of the existing "undertakers" have an unpleasant prospect.

We hope that before these rules are adopted by the Home Office a conference will be held, to which all high tension station engineers shall be invited, so that their views may be considered upon a matter of such serious importance to them and their staff. The success of a similar conference, held by the Board of Trade last year, and the valuable amendments suggested by various practical men, and adopted by the Board, are sufficient evidence of its advisability, and the Home Office will do well to follow their example.

THE POWER DEVELOPMENT COMPANY OF SAN FRANCISCO.

THE Power Development Company of San Francisco, California, U.S.A., have completed and are now operating their electric power transmission plant on the Keon River, Keon County, California. The generating plant is located 16 miles from the town last named at a point where the Keon river debouches from the fastnesses of the great Sierra Nevada mountain range, its course for a hundred miles or more being between the granite walls of a narrow canon, which in many places are more than a thousand feet in height. Some idea of the character of this rift in the rocks can be had from fig. 1, showing the flume that carries the water to the Power Company's generating station, and the character of much of the "ground" over which it had to be carried.

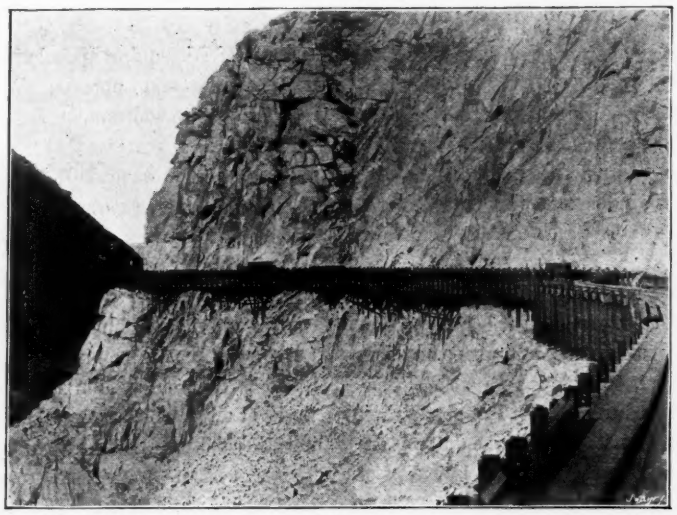


FIG. 1.

The water is taken from the river without head works, the flume being connected with the channel by a short ditch, allowing ample water to enter at a low stage, while at flood times several hundred feet of the flume are completely submerged. The character of the flume construction is apparent from our illustrations, the material is the famous California red wood, the life of which in structures of this character is almost limitless. Fig. 2 shows the interior of the flume during construction. It is 6 by 8 feet in the clear, and has a grade of 5·28 feet to the mile. While it has great carrying capacity, it is not so large as would be imagined by one who mistook the pony for a Clydesdale horse.

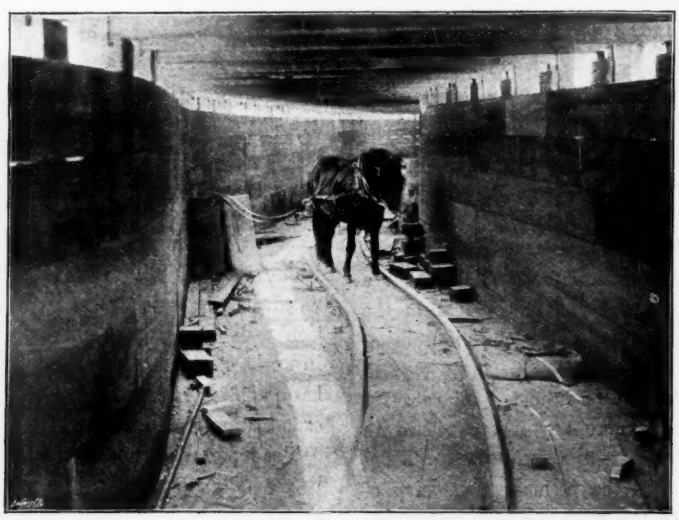


FIG. 2.

Fig. 3 shows the pressure pipe connecting the forebay at the lower end of the flume, and the receiver at the generating station, as it appeared while under construction. The pipe is made of sheet steel, varying from 10 inches B.W.G. at the upper to $\frac{3}{8}$-inch at lower end. It is 540 feet long, and drops in the run 201·9 feet. It is 5 feet 6 inches in clear diameter, has two double riveted longitudinal seams, circular seams being single riveted. This figure also gives a glimpse of the sub-structure of the generating station.

Fig. 4 is a panoramic view of the generating station and auxiliary buildings, superintendent's cottage, employés quarters, forebay main wash-gate pipe line after completion, &c. The main waste-gate is operated from within the generating station by an hydraulic cylinder, enabling the operatives to control the depth of the water in the forebay without leaving the station building, an annunciator showing the height at all times.

Fig. 5 shows the inside arrangement of the generating station, which is at present equipped with two General Electric Company's 450 kw. alternators, directly connected to two sets of Girard water wheels of 750 H.P. each. These machines are operated at 257 revs. per minute; 60 cycles, 7,200 alternations; voltage on machines, 500. The current passes through the switchboard to the low side of a double bank (3 160-kw. transformers in each bank) of raising transformers located across the further end of the station, where the potential is raised to 11,500 volts, thence to the H.I. switchboard, which is shown over the machines, and on to the line.

Water is admitted to or out from the water wheels by means of hydraulic gates, one of which appears in the left foreground; these are operated from a hydraulic stand (not shown in fig.) at the right of the switchboard. The pipe opened and closed by these hydraulic gates is 22 inches diameter.

Fig. 6 shows line construction crew at work. The line consists of 6 (2 circuits) 4 B. and S. wires on a single line of sawn redwood poles, varying from 50 to 26 feet in length, 43 poles to the mile.

The wires are carried on triple petticoat porcelain insulators, weighing about 5 lbs. each. The line is about 14 miles long, and traverses a stretch of arid land; drop in line about $7\frac{1}{2}$ per cent. of voltage at generating end.

Fig. 7 is the interior of the receiving station in Bakersfield. The high tension switchboard, it will be noted, is enclosed in a plate glass case. Here are two banks of three 75 kw. lowering transformers, 11,000 to 2,000 volts, at which voltage local distribution is made. A large part of the current is carried through and beyond the receiving station, being transformed to working voltage at points of use.

The sub (or receiving) station in Bakersfield, as well as the transformer room, contains extensive warerooms and the local offices of the Power Development Company.

The town of Bakersfield is at the extreme southerly end of the San Joaquin Valley, famed far and near for its salubrious climate and the unequalled fertility of the soil, which, when irrigated, produces in profusion all the cereals and all the deciduous fruits of the temperate and semi-tropic zones, but without irrigation is a verdureless desert. The Power Development Company plant is designed chiefly as an

auxiliary to the great irrigation system of the Keon County Land Company, which, by the way, is the largest private irrigation system in the world, consisting, as it does, of nearly 3,000 miles of main and lateral canals and ditches.

All power transmission plants claim some special features, and doubtless have them. If any attach to this other than such as the natural conditions met and overcome forced upon it, they consist in the excellent character of the work, the company asserting that America does not contain a finer specimen of the handiwork of the construction engineer, economy, permanence and utility considered.

THE LOCALISATION OF FAULTS IN UNDERGROUND MAINS.

The subject of Mr. Quin's paper is one to which too little attention has been paid in the past, and is eminently suitable for discussion at a meeting of Municipal Electrical Engineers, all of whom have cable networks to maintain in good working order. The author deals with the localisation of a fault in three steps; first, the location of the section or district in which it exists, then that of the faulty branch of the network, and finally the fixing of the exact position of the fault in the faulty branch. Nothing, however, is said of the preliminary stage, *i.e.*, the notification of the existence of a fault, except a reference to the ancient lamp signal method, which is justly condemned as unreliable. It would, however, have been better not to have mentioned this stage at all, or else to have described some other and more satisfactory methods, such as those employing voltmeters in various ways; as the impression left after a perusal of this part of the paper is that this misleading lamp method is the one most generally employed, and is therefore the best one known to municipal engineers.

Fig. 3.—Power Development Company, San Francisco.

Of the several methods suggested for locating the district in which the fault exists, Mr. Quin expresses a preference for the telephone signal system, but it is not clear from the paper whether he has actually had practical experience of it; and we must confess that after studying the brief description of this system given in the paper, we are not very sanguine of its practicability. Indeed, except when there is one very bad fault in a network of which the general leakage is small, we have rarely found that satisfactory results can be obtained except by dividing the network into sections, each fed separately by one or more feeders.

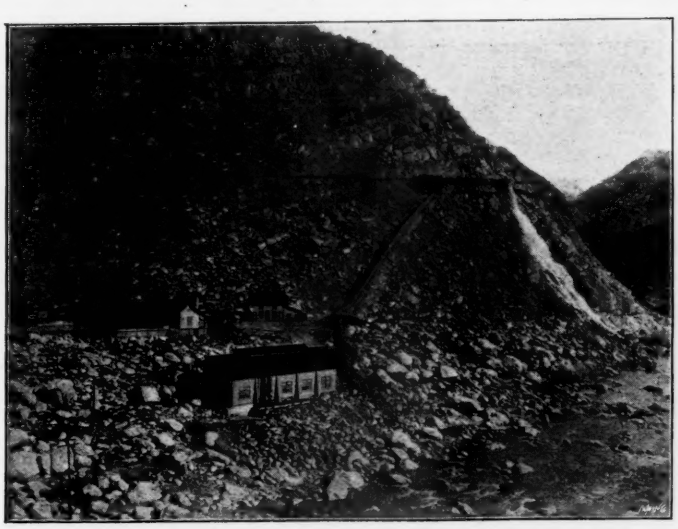


Fig. 4.—Power Development Company, San Francisco.

Having by one of the methods described found the faulty district, the author of the paper proposes to locate the faulty branch by using a differential ammeter inserted in the main feeding the faulty section, which must at all other points be disconnected from the network. This method might be used also for the earlier step, and should give good results if the ammeter can be made sensitive enough; but the minimum reading of 3 amperes in the instrument described in the paper is much too high for general use, although it may have been suitable for lead-covered cables, in which the fault resistance is said to be of the order of 1 ohm.

The third stage, that of accurately fixing the position of the fault in the faulty length of cable, is spoken of as the most difficult, and this is undoubtedly true in the case of mains laid on the built-in system; but with a drawing-in system this difficulty disappears, as it is no longer necessary to locate the fault within a few yards, but merely to find between what pair of adjacent boxes the fault lies. Mr. Quin mentions several methods that he has tried, but has had to abandon as unreliable, and we agree with him in his remarks about the induction coil and compass methods when the conductors are surrounded by a metallic pipe or sheathing; but his condemnation of the loop test is too sweeping, as in many cases it is capable of giving very useful results. He then describes a modification of the compass method, which has given him good results; but as it can only be applied to very low resistance faults, and is unreliable unless all other cables in the same trench are disconnected, there must be many cases in which it would be of no use.

His final method, in which he uses an induction coil, and applies intermittent currents of different periodicities at the two ends of the faulty cable, is very ingenious; but the description given of it is brief, and is not much helped by the very sketchy diagram of the general connections. This is to be regretted, as this method is recommended as the most reliable of all, and it would have been interesting to have heard more particulars as to the number of cells and conditions of working which have been found most convenient, and whether the author works with independent batteries as shown in the sketch or takes current from the network.

Mr. Quin concludes his paper by mentioning some of the qualifications which should be possessed by the engineer in

charge of the mains; but we are afraid that he will not find many who come up to his standard, unless he can persuade municipal electric lighting committees that it will be worth their while to appoint really experienced men and pay them a salary commensurate with the importance of their work. When he has got thus far, the prophetic utterance in the last paragraph of his paper may not be quite so rash as it must appear now; but even then we are afraid that the practical investigations of the qualified mains engineer will not enable him to arrive at the long looked for perfect cable unless he has first graduated in the laboratory and cable factory, and is not too proud to accept the aid of the cable manufacturer in working out the details of construction.

COMBINED LIGHTING AND TRACTION STATIONS.

The International Tramways Union (foreign counterpart of our Tramways Institute, but twice as energetic and up to date in its discussions and annual meetings) decided last year when assembling at Stockholm, to send out a series of questions to the engineers of electric tramways already at work, asking for information upon such points as the average consumption of energy per car kilometre or per ton kilometre, the cost of energy per unit inclusive of certain fixed charges, or the cost per unit when furnished by a lighting station or independent source.

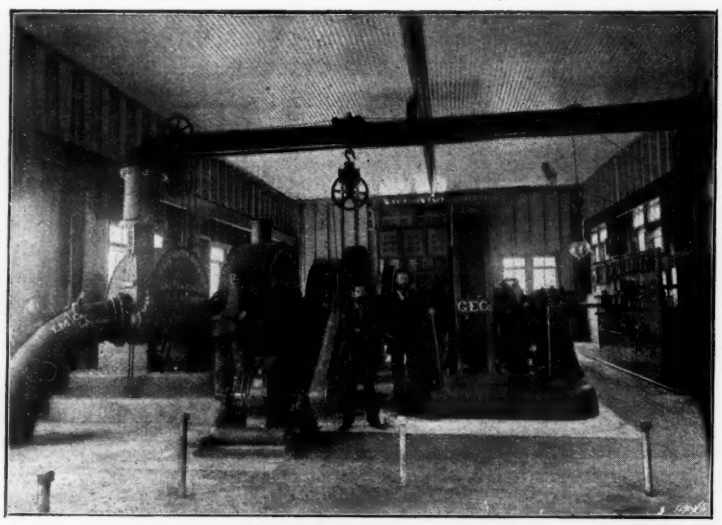


Fig. 5.—Power Development Company, San Francisco.

As might perhaps have been expected, no very definite replies were forthcoming to these questions, at least in such quantity and detail as would allow of broad conclusions to be drawn; but Monsieur Van Vloten (to whom was entrusted the task of compiling a report based upon such replies as came in) has managed to set forth some interesting, if not very novel information, with regard to the particular point of combined working, and an abstract of the report published in the French electrical papers offers some figures that may help in deciding as to the use of lighting stations already at work for supply to a tramway system also, or conversely as to the provision of lighting plant in existing tramway power houses.

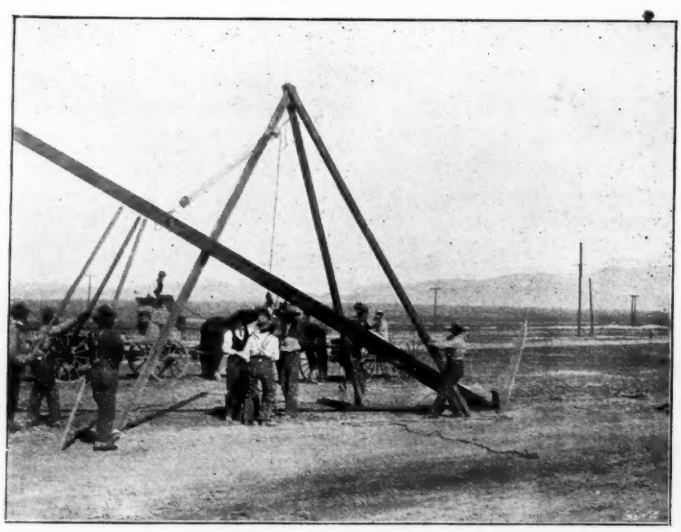


Fig. 6.—Power Development Company, San Francisco.

Most of the figures thus given are derived from the Hamburg stations, which represent the largest system of combined working in operation up to date; its details, however, are so well known, that we need do no more than say there are two power houses, the first containing two 600 H.P. steam sets and two battery sets for lighting, and also four 600 H.P. steam sets for the tramways. The second comprises larger units, and has a total output of 5,000 H.P., motor transformers serving to interconnect the lighting and traction circuits.

For the month of December, 1895 (the most recent figures, apparently, given in the report), each generator in regular work at the first station ran on the average 15·3 hours per day; the output during this time being 88 per cent. of the maximum machine capacity, which may be considered a tolerably good load factor, and only obtainable with accumulators. Spread over the 24 hours, the ratio is 56 per cent.—still a high factor compared with ordinary lighting station work. The accumulators gave a useful efficiency of 87·3 per cent., absorbing 46,695 units, and giving out 39,798; the loss in this direction being only ·9 of the total output for the month —695,263 units.

Of the 687,323 units sent into the mains, station lighting, &c., took 5,879; private consumers, 187,611; public lighting, 7,404; and the tramways, 385,318 units. This gives a conductor loss of 14·8 per cent. The total car kilometres (allowing for trail cars) amounted to 805,810, so that the units per car kilometre amount to ·477 (the abstract gives 477 *kilo*-watt-hours per car kilometre, which is absurd; it should be 477 watt-hours, or else ·477 kilowatt-hours.) This corresponds to about 745 watt-hours per car mile, or 1 H.P. hour, which is well inside the figure usually allowed in estimating the average energy consumption, viz., 1 unit per car mile. The coal burnt per unit generated, inclusive of lighting up, was not more than 2½ lbs., and the total working costs ·654 penny per unit generated.

Monsieur Van Vloten thinks that even this low cost will be diminished by employing larger machines; moreover, he urges that the traction results suffer from being mixed up with lighting, by reason of the more skilled and elaborate regulation of pressure for the latter service. He does not therefore advise electric tramway interests to buy their energy from a lighting station. Nor does the converse problem—of supplying circuits for electric light from a tramway power house—solve out with satisfaction to the mind of Mons. Van Vloten. There are undoubted advantages in such a combination; for instance, the heavy lighting season comes on throughout the winter, when tramway traffic, as a rule, is

light; conversely, current is not required so much for light in the summer time, when the tramcars are regularly overloaded. If the same machines are therefore used for both, coupled with motor transformers, the reserve may be reduced to a minimum; but even then the waste in transformation may more than balance interest and depreciation upon larger reserve plant.

It is much to the advantage of electric lighting interests to sell current for electric traction; the converse is more or less problematical.

A CRITICISM OF THE SCIENCE AND ART EXAMINATION.

By W. PERREN MAYCOCK, M.I.E.E.

Last year, in the pages of this Journal, I had the privilege of criticising the Science and Art Department's examination paper on "Magnetism and Electricity," in an article named as above (Electrical Review, August 21st, 1896, p. 250). I now propose to deal briefly with this year's paper.

The subject is still called *Magnetism and Electricity*, instead of *Electricity and Magnetism*, as nine people out of ten would write it nowadays; and it is still divided into Magnetism, "Frictional" Electricity, and "Voltaic" Electricity. How many more years are to elapse, I wonder, before the examiners, or those responsible for the headings of the paper, will see that the two latter terms are not only meaningless, but idiotic.

The term "positive electricity" occurs in two questions (6 and 27), and in another question (7) the examinee is asked to "*explain the circumstances under which it is possible for a spark to pass between two conductors charged with the same kind of electricity.*" In all of these three cases the word "electrification" should have been used instead of "electricity." How many "kinds" of electricity are there?

The time-honoured Daniell's cell forms the subject of one question (10), while the tangent galvanometer comes in for consideration in two (33 and 43).

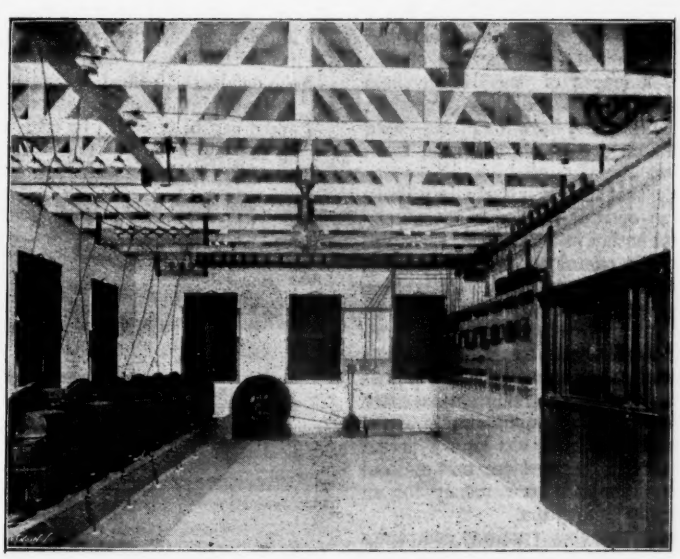


Fig. 7.—Power Development Company, San Francisco.

In the magnetism sections there are three questions (4, 22, and 24) dealing more or less directly with the earth's magnetism, two relating to the magnetic fields of bar magnets (1 and 2), and one (21) in which the comparison of "magnetic moments" is required. These are matters which have grown quite hoary in the service of the examination, and might well be given a rest now and then.

There are undoubted signs of some improvement, however, in the matter of some of the questions, though the improvement is very, very slow. For instance, the examiners have condescended to notice such—to them—comparatively modern matters as the construction and action of a Cardew voltmeter, hysteresis, construction of a simple dynamo, application of Ohm's law, and practical units, &c.

There is no particle of doubt but that whatever small movement in the direction of modernisation has been made in past years, it has not been nearly great enough. One would have expected that with the spread of electro-technical education there would be a corresponding increase in the number of students attending science and art classes; but in my own experience at Croydon the reverse has been the case. As the numbers in the electric lighting and other practical electrical classes increased, the attendance at the science and art classes diminished; so much so, that for one session at least the latter were discontinued. This state of things exists elsewhere, but to what extent I do not know. It is a fact that in one London Polytechnic the entries for the Science and Art class this session numbered six, as against 25 in session 1895-96. Contrast this with the entries for the classes in wiring and electrical engineering at the same place, which numbered 50 and 70 respectively. From a correspondent in the West of England I hear that the Science and Art class has been discontinued.

Instead of the Science and Art Examination—especially the elementary stage thereof—furnishing the necessary scientific grounding for students taking up electro-technical subjects, and acting as a feeder for practical electrical classes, as it should do, it dawdles so hopelessly in the rear as to have become quite a synonym for stagnation in the minds of both teachers and students.

THE TRAMWAYS INSTITUTE.

In its present position the Tramways Institute reminds one rather of the well-known "Popular Educator" picture of "The Boy: What will He Become?" Comparatively speaking the Institute is young—having only last week celebrated its tenth annual dinner—it is showing signs of more vigour than appeared likely or even possible a few years ago, and it only requires a few active, eager young engineers to join—not merely as members but as workers in developing the Institute—for it to achieve no small measure of useful and profitable success.

Perhaps as corporation and municipal electric tramways generally develop and increase, the men in charge of them (who are almost without exception on the sunny side of forty) can be induced to join the Institute and help to push it along; but there are already two somewhat powerful associations in the field, either of which might suitably embrace the new class of municipal engineer—we refer to the Incorporated Association of Municipal and County Engineers and to the Municipal Electrical Engineers' Association. If the Tramways Institute is to secure for itself the daily increasing number of electric tramway engineers, it must bestir itself still more, and show through its officials not an unreasoning dislike or enmity towards things municipal because of the results due to a certain Tramway Act passed in 1870, but rather a fixed determination to make the best of a bad bargain proving that tramway companies—to quote one of the speakers at the annual dinner—are not all promoters and thieves, any more than municipal authorities are bandits and robbers, seeking to take what is not theirs and pay nothing for it.

The statement cannot be too strongly emphasised that in many cases tramway companies, irrespective of the past, and regardless of Acts or promotors, are most necessary and advisable parts of our industrial mechanism. Doubtless the vast majority of our city tramways will be owned by the

local authority in each instance, but more often than not (as an example, take London itself) it will pay better to lease the lines to a company than operate them by the municipality itself, in view of the interchange of traffic outside the boundaries. With interurban services, the company is practically essential; for it is most difficult to arrange and work satisfactorily with an elective joint committee representing several districts and interests of a possibly conflicting nature.

For corporations, therefore, to look on tramway companies as useless encumbrances, which must be put an end to as soon as possible, is just as absurd as for some of the tramway companies to make a wry face and accuse municipalities of robbery because of the unfortunate and unjust position the companies are in to-day owing to the 1870 Act.

The proper course to adopt is for both to agree upon a *modus vivendi*, and work together amicably for the improvement of public quick transit.

We are pleased to see that there is a much greater tendency in this respect on the part of both interests than has hitherto been the case, and the Tramways Institute dinner showed this very markedly. The lion and the lamb were literally sitting together side by side, and the one was not inside the other. Earl Russell of the London County Council, Alderman Bray of Plymouth, and the chairman and president himself—are all representatives of municipal governments; yet they spoke appreciatively enough of what tramway companies had done, and still more of what they could and would do; so that next year we may hope to see conflicting interests gradually merging into consideration of the work to be done—the carrying of passengers quickly, safely, and cheaply—rather than wasting time in disputes as to whether 17 or 21 years is enough for a tramway company to become bankrupt in.

No more pungent remark, or one which better deserves to be printed in prominent red ink and sent round to every local authority in the kingdom, was made throughout the entire meeting than that which fell from the lips of Mr. Pogson, the engineer and manager of the Huddersfield Tramways (which, as our readers will doubtless remember, have been operated by the municipality for a long time—long enough to give Mr. Pogson a chance of learning the truth from sad experience).

Mr. Pogson said distinctly that it was utterly impossible with any mode of traction to operate tramways so successfully as to redeem the capital outlay in 21 years! Electrical engineers learnt this long ago in regard to electric lighting, and the same is true even with respect to the extremely cheap system of working tramways with overhead trolley wires. So much for the Act of 1870; it is quite clear, now, that municipalities were then smart enough to ask for more than they deserved, whilst tramway promoters were so keen to get lines built, that they swallowed anything—as though with horse cars one could in every case redeem capital in 21 years! Thirty, or even 40, years do not represent too long a period even with the advantages of electric traction; and no local authority at the present time would borrow money for an electric tramway at less than 30 to 35 years.

It is therefore much to be hoped that tramway companies and municipalities will join together in agreeing upon more favourable terms, lest the passenger-carrying industry be choked altogether. There are some signs of this, as for instance, the lease now arranged between the London County Council and the principal metropolitan tramway company. Moreover, at the Institute meeting, it was stated by Mr. Sellon that with regard to one line to be constructed under the Light Railways Act, the local authority had arranged to have the option of purchase at the end of 35 years on a valuation as a going concern.

Therefore we may conclude either that the Light Railways Act will continue to be "a back door entrance" for tramways—new or converted and extended, or else the 1870 Act will be amended by the dictates of common sense, not to say experience.

SIGNALLING THROUGH CABLES.

In the July number of the *Philosophical Magazine* Mr. W. A. Price discusses the question of telegraphing through a cable having two conductors, one central, the other concentric. It was proposed to cut these conductors alternately at different points and convey the electrical disturbance by induction through the dielectric. The signalling charge is to be introduced into the central conductor, which would be interrupted, say 300 miles from shore. The disturbance is carried on through the concentric conductor, induced through the dielectric of the first 300 miles. At 600 miles the concentric conductor is interrupted, and the disturbance passes on along the central conductor and so on. The conclusion arrived at is that such an arrangement would be inferior to a continuous cable signalling through only one conductor, though a preliminary experiment on an artificial cable led the author to believe some improvement was to be expected.

In the discussion of the propagation of the currents along the conductors of a concentric cable, it is shown to what extent the presence of the one assists the action of the other. It is possible in a cable having rather a small conductor for the size of the core to increase the speed by replacing part of the gutta-percha by a perfectly insulated concentric conductor; though in every case where such an improvement is possible the best position for the extra copper is close round the central conductor. It follows too that if part of the conductor of a cable, say one strand of a 7 strand conductor, were completely insulated by a coat of dielectric from the remainder, the speed through that one strand would be the same as if the whole conductor were connected. The remainder of the conductor, by its peristaltic action assists the one strand exactly as if it were in electrical contact with it throughout.

So for the propagation of electrical disturbances two insulated conductors in a cable, however dissimilar they may be in form and size are exactly equivalent to one another, and each is equivalent in its action to a pair of independent single conductors having different values of K R, the propagation of an electrical disturbance along such a conductor being the sum of the propagations along the equivalent pair. It is not possible, however, to arrange the cable so that the K R of either one of equivalent pair is lower than the K R of the conductor formed by putting the whole of the copper of the cable into one central conductor, so that no increase of speed can be obtained by such a construction.

In the course of the mathematical investigation summations of the following series are obtained by a partly physical argument.

$$\pm \frac{1}{1+n^4} + \frac{1}{1+2^4 n^4} \pm \frac{1}{1+3^4 n^4} + \frac{1}{1+4^4 n^4} \pm$$

and

$$\pm \frac{n^2}{1+n^4} + \frac{2^2 n^2}{1+2^4 n^4} \pm \frac{3^2 n^2}{1+3^4 n^4} + \frac{4^2 n^2}{1+4^4 n^4} \pm$$

THE CASSEL GOLD COMPANY.

By E. ANDREOLI.

(*Continued from page* 112.)

It is immaterial whether Mr. MacArthur has invented the use of cyanide of potassium as a solvent for gold contained in ores, which is mentioned in a letter written in 1865 by Dr. H. Wurtz to Mr. W. Crookes. The indisputable fact is that he has been the first to apply cyanide of potassium to the commercial extraction of the precious metal, and that he has rendered a splendid service to the industry of gold, which his process has entirely transformed. He has merited the universal gratitude of the mining world, and nobody will grudge him the praises he deserves.

He dissolves the gold, which is in a very fine state of division, by means of a weak cyanide solution of potassium cyanide, and precipitates the gold from its solution by means of zinc shavings. Many are the drawbacks of the zinc treatment of the cyanide of gold solution; still it has been found satisfactory, and there are many miners who prefer to use it as it is, rather than adopt the electrolytic method, however more advantageous it may be.

One is at a loss to understand the motives which induced Mr. MacArthur to repudiate the zinc system, of which he was the pioneer, and to enlist in the army of electrolysis, under the banner of a process, which he says he has found,

and which "will yield satisfactory results, with economy in cost, time and labour."

There are very few electricians who are not aware that Messrs. Siemens & Halske in their electrolytic tanks for the deposition of gold from a weak cyanide of potassium solution use iron anodes and lead cathodes. The anodes used by Mr. MacArthur are made of iron *coated with graphite or other form of carbon* or with lead; his cathodes may consist of iron or steel plates coated with lead. Neither iron nor graphite seems to be the suitable material to be employed at the positive pole in a cyanide solution. Carbon, particularly, is objectionable, as it falls into an impalpable powder, which cannot be considered as absolutely facilitating the recovery of the gold in the solution. The union of carbon and iron at the anode in such a solution cannot be decidedly called a happy one. Evidently Mr. MacArthur does not know what havoc can be done by the local action which takes place between an iron anode and another metal, or carbon. From a practical point of view there is no difference at all between depositing gold on lead as Messrs. Siemens do and depositing it, as Mr. MacArthur does, on a layer of lead with which an iron cathode is coated! The MacArthur process is complicated by the operation of coating his iron cathodes with lead; he does not tell us how he coats his iron plates with lead, but it cannot be a very easy work.

We must be thankful for the trouble Mr. MacArthur has taken to explain the object of this coating of the anodes. He says that it is desired, as far as possible, to prevent the formation of ferrocyanides or their insoluble salts at the anode, but evidently Mr. MacArthur has missed his aim. With a very weak current, it is possible to bring to a minimum the formation of ferro-cyanide by an iron anode, but if iron is coated with lead, the case is worse. Cyanide of lead is ten times more dangerous than ferro-cyanide; the solution becomes milky; the longer the electrolysis is carried on, the more the lead plates are attacked, and the liquid becomes thicker. There is no possible deposition of gold from an electrolyte contaminated with lead, and the combination of lead cyanide and of Prussian blue produces such a mud that the tank must soon be emptied, with this aggravating fact, that the anodes are deteriorated, the cyanide of potassium of the solution is lost, and the gold in solution almost unrecoverable.

I must also mention the most unpleasant short circuit which takes place between the electrodes, owing to the thick mud of cyanide of lead which falls rapidly to the bottom of the tank.

This part of the new method for the electro-deposition of gold is a meagre copy of the Siemens process; Mr. MacArthur has evidently some very peculiar views as to the *rôle* of metals and metallic substances. He proposes, for instance, the use of iron or steel anodes coated with lead oxide. Iron coated with lead oxide! Which oxide? Not protoxide of lead, of course. It looks indeed as if Mr. MacArthur had never heard of that unpleasant thing which is called local action. Be it protoxide of lead or peroxide of lead, there will always be an energetic local action between iron and the oxide of lead, with the destruction of the plates and the contamination of the electrolyte as ultimate result.

I regret, also, to tell Mr. MacArthur that, even if an iron anode coated with peroxide of lead could suit his purposes, he would not be entitled to work with it, because this is a process which had already been invented before he took a fancy for electrolysis. The man who fought so many battles to defend the monopoly of cyanide of potassium ought to respect the rights of other inventors.

Another extraordinary feature of the invention of Mr. MacArthur is the mode he has selected of coating his iron anode with graphite. He mixes the graphite in a powdered condition with an extremely small quantity of a *varnish* or *rosin diluted with a volatile solvent*, and he brushes the mixture on the plates.

The gold is deposited on the cathodes and is removed by brushing. How much gold is lost during this operation? Would it not be much more advantageous to burn the gilt carbon coating with its varnish, or to redissolve the varnish and put the gold and graphite in a furnace?

In the MacArthur tanks, "the plates may be made alternately anodes and cathodes, or the plates at the end of a series, can be connected respectively to the positive and negative pole of the electric source; or with alternating anode and cathode, plates may be severally connected, the anode plates of a second vat or series, the cathode plates of which are connected to a negative conductor."

We are not much more advanced with these explanations, but Mr. MacArthur has no preference for any particular arrangement, and he says that he can adopt any other suitable known disposition of the plates and current connections as well "as electric current of various *strengths* and *kinds*."

Mr. MacArthur will do well if he returns to his old love, the precipitation of gold by zinc shavings, instead of abandoning it for electrolysis, in which he does not seem to be brilliantly proficient. He has revolutionised the gold industry, this must be sufficient for him, and he must let others gain fame and honour on the field of electrolysis.

Mr. Alfred James, of the Cassel Gold Extraction Company, is not to be so much criticised as Mr. MacArthur for his faulty knowledge of what can be or cannot be practically done in an electrolytical tank; but what is true, real, and efficient in his method was known before he attempted to apply it, and what is new in his process is of little or no importance.

(To be concluded.)

SOME METHODS OF TESTING MOTORS.*

By FRANK B. PORTER.

One of the most important things in the keeping in repair of street railway motor equipments should be a careful testing of the electrical resistance of different parts of the equipment at regular intervals, or when a motor is brought into the shop for overhauling or repair, so that parts that are defective may be removed and replaced by ones in good condition before further damage is done. The danger of delay in replacing defective parts may be considerable. For instance, an armature of a motor, in which a field coil is short circuited in some of its layers and is consequently of less resistance than it should be, is subjected to a much larger duty by means of working in this weak field. The extra current resulting usually causes the armature to burn out in a short time, provided the fault is not discovered and repaired, necessitating sometimes, according to the design of the armature and the extent or location of the burn-out, a complete rewinding. This may be quite expensive, to say nothing of disturbed or delayed travel on the line which often takes place when a car is crippled in service.

Repair foremen as a rule have had long experience in the behaviour of motors under various conditions. To this experience should be added a clear idea of the wiring connections of the controlling apparatus and the motor, so that they will be able to test for grounds or open circuits with the magneto or a lamp circuit, and this knowledge should be supplemented by an understanding of the use of instruments, and the methods of testing resistances by them. Then troubles will be readily discovered, and by a systematic application of this knowledge many accidents may be averted. Unfortunately, in some street railway shops no instruments are furnished, and in others testing is regarded as experimenting, for which there is no time. In still others testing is practised without system, and at irregular or long intervals, or only where some special case seems to warrant the use of some unusual means to arrive at a conclusion. The writer in this article has endeavoured to submit, in a simple and practical form some of the most useful tests that are ordinarily used by electrical engineers, and can be easily applied to the equipment of street railway motors.

Fig. 1 represents the connections for measuring a low resistance by means of an ammeter and a voltmeter. This method, with suitable instruments, will serve to measure or test the electrical resistance of any part of a street railway motor equipment (except the insulation), the starting resistance, resistance of field shunts, resistance of field, resistance of armature, &c. Suppose x is a field coil, and its resistance is sought. Connect in series with it as shown, an ammeter, *c*, with which to measure the current; a fuse, f, for safety;

* *Street Railway Journal.*

a switch, S, with which to open and close the circuit, and a resistance, R, to prevent an amount of current in the circuit that would be more than the capacity of the ammeter, *c*, *i.e.*, more than it can indicate; too much current would also heat the field being tested to a much higher temperature than the surrounding air, and consequently increase its resistance. Place a voltmeter, E, alongside of ammeter, *c*, and connect each binding post with one terminal of the field to be tested. Have the instruments connected so that the current will pass through them in the right direction. This will probably be shown by marks on one or both of the binding posts of the instruments.

To measure the resistance now close switch, S, and take a reading of both voltmeter, E, and ammeter, *c*; then the resistance of $X = \frac{E}{c}$, or the resistance of the field being tested equals the reading of the voltmeter, divided by the reading of the ammeter. For example, if the voltmeter

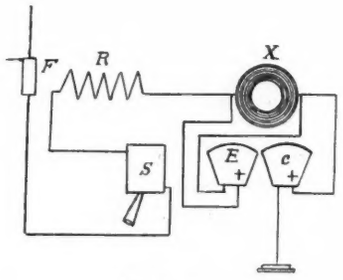


FIG. 1.

reading is 30 volts, and the ammeter reading is 60 amperes, the resistance of the field is $\frac{30}{60} = \frac{1}{2}$ ohm. In testing fields quite large currents can be used without heating, and the larger the current used the less the error from an incorrect reading. For if with a current of 50 amperes the person making the test should read 1 volt out of the way the error would be $\frac{1}{50}$ or ·02. But with 25 amperes, the error would be $\frac{1}{25}$ or ·04, double the error of the first case with the larger current.

In testing field shunts, or motor starting resistance, it will be found that a large current will quickly heat the resistance under test, and it will be more accurate unless the method of correction for temperature be understood and applied, to use a current that will not materially heat the resistance being tested.

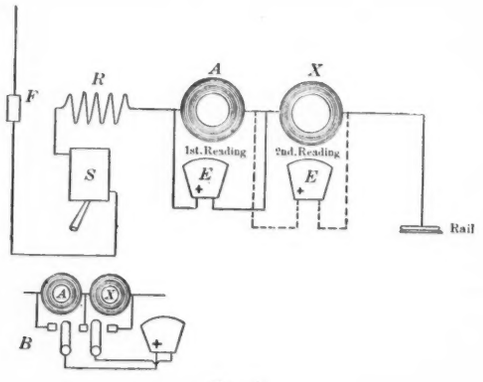


FIG. 2.

The method shown in fig. 1, in which a suitable low reading voltmeter is used, will accurately test the total resistance of an armature, but for locating short circuited coils a somewhat different method will give better results, which is given below in fig. 5. If an ammeter be not at hand, but a voltmeter is, resistances can be tested or measured by means of it and another known resistance, as in fig. 2.

Connect in series the known resistance, A, and the resistance to be tested, X, and if they two have not enough resistance to prevent an excess of current, put other resistance in series with them, as R. A fuse, F, and a switch, S, should also be in series in the circuit. Now shunt the known resistance, A, as shown in fig. 2, with voltmeter, E, and note reading; call this first reading V. Then change terminals so that the voltmeter shunts the unknown resistance, X; note reading, and call it V′. If the resistance of A = *p*, then $p\,\frac{V'}{V}$ = resistance of X; that is, the quotient obtained by dividing the second reading by the first reading, multiplied by the known resistance equals the resistance of X. If V = 20 volts, V′ = 30 volts, and *p* = 1·2 ohm, the resistance of X = 1·8. In order to quickly change from the first to the second reading, a special switch is shown at B.

The exact accuracy of this test depends on the current and voltage being constant. If the different readings be taken with the resistances at a constant temperature, the only error would be due to a variation in line voltage (*i.e.*, power station). This error would not be important enough to destroy the value of the test, for if R = 10 ohms, and A and X = $\frac{1}{2}$ ohm each, with a line of pressure of 500 volts, the drop in voltage around the terminals of A and X would be 22·72 + volts each. If on a second reading the line pressure had increased to 520 volts, the drop in voltage around the terminals of A and X would be 23·63 +, or a difference between the first and second reading of ·91 volt or an error of almost 4 per cent; but short circuits or high resistances which are liable to occur in the motor equipment in street railway practice are so considerable, that even an error as large as 4 per cent. may be neglected. If desired the result may be checked by several different readings, or if two voltmeters are available, by putting one across the circuit from trolley to rail, and noting the line voltage when the readings are taken.

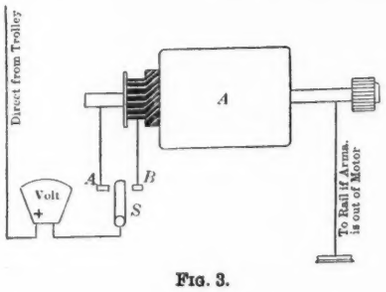


FIG. 3.

The nearer the resistance of A equals the resistance of X, the better the result. It is also preferable to have resistance of A of the same character as the resistance of X; for example, if X be a field to be tested, let A be a similar field, but of a known and standard resistance.

To test the insulation of an armature, field, or any part of the electrical equipment of the motor, connect a voltmeter (fig. 3) to a two-way switch whose contact points are shown at A and B, then close the circuit A, and note reading; call it H, then close circuit B, and note reading; call it G, then the insulation resistance of the armature

$$A = \left(\frac{H}{G} - 1\right) R,$$

where R is the resistance of the voltmeter, which is usually marked on the instrument or case; on Weston instruments on the inside of case cover. That is, from the quotient obtained by dividing the reading of line pressure by the reading in series, subtract one and multiply by the resistance of the voltmeter. If H = 500 volts, G = 10 volts, and R = 70,000 ohms, then the insulation of A = (500 ÷ 10) − 1 × (70,000) = 3,430,000 = 3·43 megohms.

This also supposes the voltage of the line to be constant, but the error will be so small with an ordinary variation in station voltage that it need not be taken into account here.

The above test is suitable for high insulation resistances, say, above 1,000 ohms, when the insulation has a very low resistance, *i.e.*, when a high reading is noted with the voltmeter in series. A better method would be to introduce a low reading ammeter into the circuit, in series with the insu-

lation resistance, while the voltmeter shunts it. (See fig. 4.) Then the formula is identical with the first case considered, the insulation resistance now equals the quotient of the reading of voltmeter, divided by reading of ammeter, *i.e.*,

insulation resistance $= \frac{E}{C}$. If the voltmeter reading = 500 volts and ammeter reading $= \frac{1}{2} = \cdot 5$ ampere, the insulation resistance of A would be $500 + \cdot 5 = 1{,}000$ ohms.

The next problem to be considered is that shown in fig. 5, of locating a short circuited coil in an armature of a motor with a bipolar field. Connect an ammeter in series with a suitable resistance in one of the brush-holders, P, connect the other brush-holder, M, to rail, then take voltmeter terminals (low reading voltmeter), K and H, insulated except at the point, so that they can be held in the hand, and make

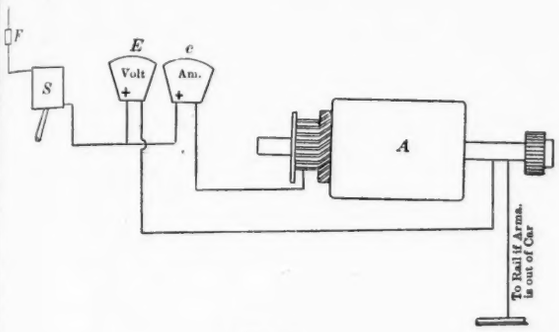


FIG. 4.

contact with them upon two adjacent segments of the commutator, say, *a* and *b*, and note reading, then change the points, K and H, to commutator bars, *b* and *c*, and note reading. If resistance of armature coil, *a b*, equal resistance of armature coil, *b c*, the reading will be the same in each case, and so on all around the commutator, from *a* to *b*, *b* to *c*, *c* to *d*, *d* to *e*, &c.

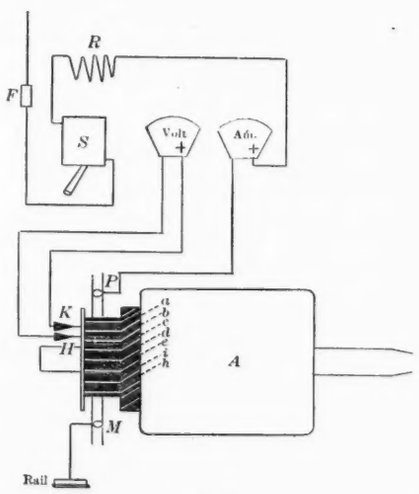


FIG. 5.

A short-circuited coil will give a low reading, a high resistance coil a higher reading and a coil short-circuited at its terminals, or at the commutator segments, would give practically no reading when the voltmeter terminals were brought into contact. The current should be constant, but as there is an ammeter in circuit any variation could be noted and allowances made.

If the resistance of coil, *a b*, be known, then formulæ of the second case considered applies to this test, and the reading of *b c* divided by *a b* and multiplied by resistance of *a b*, equals the resistance of *b c*;

$$\text{resistance of coil } b\,c = \left(\frac{\text{volts } b\,c}{\text{volts } a\,b}\right) \times \text{resistance } a\,b.$$

The instruments necessary for these tests would be a high reading voltmeter (0 to 600 volts), a high reading ammeter (0 to 150 amperes with scale division 1 ampere), a low reading voltmeter (0 to 2 volts with scale division ·01 volt), a low reading ammeter (0 to 5 amperes, with scale division of $\frac{1}{30}$th ampere). As a voltmeter which read from 0 to 600 would have scale divisions of about one division equal to 5 volts, it would be better to get this instrument with a double scale, one scale reading from 0 to 600 volts, and the other reading 0 to 150 volts, each scale division of the latter equal to 1 volt. By this means closer readings could be taken between 1 and 150 volts than is possible on the higher scale.

In commencing a test, if some approximation of the readings is not known, it would be much safer to use the high reading instruments first. If necessary, they can be removed and the low ones substituted. By varying the series resistance in a circuit the range of an instrument may be made available for many tests in any particular case. Working with as large currents as the instruments are designed for without causing a heat error, is preferable to work with weak currents and will give better results.

AN AIR-SPACE SUBMARINE CABLE.

THE paper read by Mr. W. H. Preece at the British Association last year, in which he describes his improved form of twin-core telephone cable, has done good service, inasmuch as it has directed the attention of cable manufacturers afresh to the important problem of submarine telephony. As one result, we are told that a new departure has been taken by the Telegraph Construction and Maintenance Company, who have constructed a cable, designed by Mr. Willoughby Smith and Mr. W. P. Granville, in which air is employed to reduce the capacity between the two wires of a telephone circuit.

The core, as our readers saw in our last issue, has the appearance of four separate conductors, each insulated with a thin coating of gutta; but instead of these four cores being laid up contiguously, in the usual way, a longitudinal air-space, in section like a cross having equal branches, is left in the centre of the strand, so as to diminish the electrostatic capacity between the two diagonal wires used for each metallic circuit. The four insulated wires thus laid up are additionally insulated with a substantial covering of gutta-percha, so as to form one large core.

The conductors are laid in a spiral with one turn in every 8 inches of the cable, and the air-space is divided into watertight compartments at intervals by partitions of gutta.

Tests on a length of about 2 knots laid from the Hampshire Coast to the Isle of Wight, show an inductive capacity of 0·098 microfarad per knot, between diagonal wires, for the new air-space core $\frac{940 \text{ lbs.}}{940 \text{ lbs.}}$ conductor. G.P.

It is said that the weight of gutta required to cover each of the four conductors solidly in the usual way, so that two diagonal wires would have the same small capacity, is 5,100 lbs., *i.e.*, the total gutta would be about $8\frac{1}{4}$ times as great, and the diameter over all about $1\frac{1}{2}$ times as large as the air-space core.

A powerful alternating current working through one pair of conductors did not appreciably affect telephone signals through the other pair.

That it can be safely used for shallow depths seems already sufficiently proved, but that it is an important step towards the practical solution of *ocean* telephony does not appear so certain. It seems probable that, from a mechanical point of view, the comparison would not be so favourable; for apart from the increased difficulty in construction which the air-space would seem to entail, the core does not appear suited to withstand great compression. The experimental hydraulic pressure of 700 lbs. per square inch represents a depth of 260 fathoms only. For even 1,000 fathoms the pressure would be increased to, approximately, 2,670 lbs., and it

remains to be seen whether the wires would be compressed closer together. Moreover, paying out or picking up over a drum in deep water would tend to flatten the core, and press the diagonal wires of one pair between the wires forming the other pair, and thus make the capacity between pairs very much greater, even if it did not damage the dielectric, which at this point is exceedingly thin. Laying such an air-space cable in warm climates would necessarily increase this risk.

When water gets in at a fault, the whole section between partition walls—the length of which is not stated—would have to be cut out when repaired. If the four cores adhere firmly to their outer G.P. covering, jointing would probably not be very easily effected.

Satisfactory as it has so far proved when laid in shallow water, we are inclined to think that it will not be found very suitable for ocean depths, and that some other solid insulator of higher specific capacity than air, but not greatly differing from the combination of air and gutta under consideration, will be more satisfactory for deep water cables, besides being more easily constructed, and we have reason to believe that such a desideratum will before long be forthcoming.

ADER RECORDER.

In addition to its simple construction, and the very great increase in speed which M. Ader's new cable recorder is said to have shown when compared with the siphon recorder, the absence of the "vibrator" (which frequently gives trouble and requires close attention in order to maintain a regular rate of vibration and sensibility) is decidedly another point in its favour. We have seen a specimen of signals recorded by M. Ader's instrument, and they are certainly very good and distinct. There seems little doubt that the idea of recording messages by photographic means will be adopted in the future, at any rate for working very long cables, and it seems surprising that no one has suggested its application to dead-beat reflecting galvanometers (whether on the principle of the Kelvin mirror *speaking* instrument or the Sullivan galvanometer) to avoid the fatigue experienced by the eye when following the rapid movements of a bright light. It is certain that the much smaller movements of a spot of light which would sufficiently serve if recorded by photography would enable a much higher speed to be attained than with the comparatively large amplitude required for visual telegraphy. Indeed, the extreme sensibility which the reflecting galvanometers above specified are capable of, justifies one in anticipating an even higher speed than that claimed for the Ader recorder. The following arrangement would probably meet the requirements: A light from a lamp is directed through a lens on to the galvanometer mirror in the usual way, and in the path of the ray, as it passes between the lens and the lamp, is interposed a particle of some opaque substance attached to the middle of a short length of glass fibre. The latter being transparent, the condensed beam of light reflected from the galvanometer mirror on to the regularly moving sensitised slip illuminates all the part exposed, except at a point obscured by the shadow thrown from the opaque speck on the glass fibre. Instead of a glass fibre to carry the opaque particle, the light from the lamp may pass through a thin disc of glass having a minute hole pierced in its centre, which hole may be filled up with any soft opaque substance. The sensitised slip has to be so placed that when the mirror is deflected by received signals the black speck moves over the slip at right angles to its length and traces the message which a developing bath fixes and renders visible in the form of a white line on a dark back ground, similar to M. Ader's slip. An alternative plan would be to direct a light through a very small hole in the centre of a metal plate which cuts off all other rays and allows only the fine pencil of light to pass. This bright speck is focussed by a lens on to the galvanometer mirror and its sharp image is reflected to the sensitised slip as it unrolls in the manner already explained. When the slip re-appears from the "fixing bath" the mirror movements would be shown by a black line on a white back ground. A light rich in actinic rays and of sufficient intensity that its *reflected* beam will act rapidly on a sensitised film is necessary, but in view of the photographic wonders accomplished by the "animatograph" or "kinetograph" this does not seem to present a difficulty.

SWISS ELECTRIC TRAMWAYS.

A great deal has been said with regard to the extensive development of electro-hydraulic installations in Switzerland,—that is, of electric lighting and tramway enterprises operated from the waterfalls that abound in this country of glaciers and mountains. After all, what else could be used in Switzerland but water power for the purpose?

It may be a remarkable piece of nature's balancing, but she has given water with one hand and taken away coal with the other. Hence the good folks of Zurich are not as a rule much in the habit of toasting themselves in front of a blazing English coal fire when the raw fuel costs 42s. 6d. per ton delivered, or even before a smudgy heap of Belgian stuff at about two-thirds the price.

Nor is the high price of coal in Switzerland any great inducement to use steam boilers and engines on an extensive scale. The tendency seems to be much more in the direction of economic gas generator plant and gas engines, even for the comparatively large powers required in electric traction work. Last summer, for instance, the Lausanne electric tramway system was equipped in this way with two Crossley gas engines (double cylinder) each of 130 actual horse-power, the ultimate station capacity consisting of four such units. The *Engineer* gives in the course of a brief article some further details of this station and plant. As is usual with double cylinder gas engines, the cylinders of these prime movers are placed at opposite ends of the engine, with both connecting rods leading on to the same cankpin. The crankshaft is cut out of a solid forging, and as may be supposed necessary, a very heavy fly-wheel helps to secure steady running. Even then one would expect considerable vibration or pumping, in view of the great length of engine bed. The speed is 160 revolutions, and the dynamos are each coupled direct through Raffard couplings. For the output this seems a slow speed, and would almost imply dynamos of extra massive type.

The generator gas plant comprises two generators, each 6 feet 6 inches diameter by 11 feet 6 inches high, and each designed to give sufficient gas for engines working up to 300 H.P. Belgian coal is used. As a curious item, it may be mentioned incidentally that the cost of water in Lausanne is rather high! so that a small quantity only is used for washing the gas, winged radiator coolers being fixed between the radiators and washers. A gas-holder containing about 5,650 cubic feet is provided, and is said to provide about 8 or 10 minutes' storage when all four engines are fixed. This does not seem a very large amount of storage capacity under any circumstances, compared with what one is accustomed to in other storage systems.

Electric accumulators are employed in addition, one of the engine and dynamo sets running at present for about 17 hours continuously charging the accumulator, and the second set coming into use whenever heavy traffic requires it. Only two men, it is said, are required to look after the plant—a stoker for the generators and boilers, and an engine driver, who also, presumably, takes care of the accumulators and other electrical plant. The total fuel consumption averaged over the month of November (as a typical instance) did not exceed 1·8 lb. per electrical unit generated. Doubtless the heavy cost of fuel justified heavy outlay upon plant, &c., which may suffer more depreciation than ordinary steam boilers and engines.

The Zurich Hill Tramway is operated in a similar fashion, though by means of Dowson gas; in the power-house there are three engines—two 60 H.P. actual and one 120 H.P. actual. Accumulators are also employed here, and the fuel consumption (Belgian anthracite) does not exceed 1½ lb. per effective horse-power-hour.

CORRESPONDENCE.

Prepayment Meters.

I am informed that in a recent number of the Review, in commenting upon the paper read at the Municipal Convention by Mr. H. Couzens, you give Mr. Atherton and myself credit for inventing the prepaid meter; it is quite true that the fluid meter is ours, but the more recent de-

velopment is due to Messrs. Crawley & Soames (Nalder Bros.). As I don't wish to sail under false colours, I shall be glad if you can find an opportunity of correcting this.

George Ellis.

Electric Light Station, Portsmouth,
July 24th, 1897.

Cassel Gold Company.

When reading Mr. Andreoli's article in your last issue, it occurred to me it might interest some of your readers to know more about the ingenious and novel process of Mr. MacArthur and Mr. Alfred James.

Mr. Alfred James's original specification, as filed in the Transvaal, had the following claims:—

1. In electro-precipitation of gold and silver, or gold or silver, from their cyanide solutions, the use of lead cathodes.
2. In electro-precipitation of gold and silver, or gold or silver, from their cyanide solutions, the use of lead anodes with lead cathodes.
3. In electro-precipitation of gold and silver, or gold or silver, from their cyanide solutions, the use of lead anodes with aluminium cathodes.

Mr. Alfred James, shortly before leaving England for South Africa on behalf of the Cassel Gold Company, was good enough to visit my laboratory and see my process for depositing gold on aluminium cathodes. Mr. James has had to abandon the aluminium cathode, so the new process apparently consists of using a lead anode, or cathode, or lead as an anode and cathode.

Sherard Cowper-Coles.

Distributing Systems.

The interesting paper by Mr. J. R. Blaikie, of Bristol, on the above subject, which was read before the Municipal Electrical Association on the occasion of the recent Convention at Manchester, contains a tabulated statement intended to show the kind of mains used by each of the electrical undertakings in Great Britain. The statement is given under five headings, including both "solid" and "drawing-in" systems, but among the latter no mention is made of the Doulton conduit. Having regard to the enormous extent to which this system has been adopted, its omission renders the table referred to so misleading as to call for correction. This will be obvious from the fact that the earthenware conduit has been adopted as a standard system for over 40 undertakings in Great Britain. This figure includes eight of the London supply schemes, and in many instances the Doulton conduit has been laid throughout the whole area of supply.

We think you will agree with us that a system which has proved of such utility, both for metropolitan and provincial work, should certainly have found a place in Mr. Blaikie's table.

Doulton & Co.

Kennington Road Baths.

In your issue of July 9th, you state that the installation of electric light at Kennington Road Baths was carried out "under the superintendence of Mr. A. Hessell Tiltman, F.R.I.B.A." As there are several points of novelty and interest in this installation, I feel that, in justice to Mr. J. M. G. Trezise, this statement should be corrected. Mr. Trezise has acted throughout as my consulting electrical engineer, and is responsible for the whole of the electrical work.

A. Hessell Tiltman.

July 26th, 1897.

Tramways Institute of Great Britain.

In a report of the meeting of this Institute I notice my name is included as being one of the Council. I shall be glad if you will allow me to state that this is the first formal intimation I have received of having been elected to the Council, and to add that I have never been invited to join, neither have I consented to have my name proposed.

Stephen Sellon.

I observe it stated in the Press that I have joined the Council of this Institute, and I should be glad if you would permit me to say that I have never been invited to join the Council, I have never consented to do so, and have not received any intimation from the Institute either that my name was about to be proposed, or that I have been elected to the Council.

E. Garcke.

A Strange Magnetic Freak.

Scarcely would anyone expect to find anything in the least degree strange in the magnetisation of ordinary table knives, but on careful examination the writer has found that the extreme end of the blade or rounded point appears *invariably* to be a north pole.

Several hundred knives, at widely separated places, were tried before considering the matter sufficiently established to merit a letter to this journal.

It may be pointed out that the above observations refer to table knives only (large and small) that is to say those which are fixed in handles.

A. R. U.

July 27th, 1897.

Conductivity of the Paris Cable.

Will you kindly explain (see page 104, July 23rd, 1897), in your next issue why the conductivity of the Paris cable is so low:—

640 lbs. copper wire per knot, and R = 7·48 ohms per knot!

Again:

940 lbs. copper wire per knot, and R = 5·163 ohms per knot!

What is the gauge of wire used?

A No. 14 S.W. gauge copper wire weighs 102 lbs. per *statute* mile, and R = 8·884 ohms!

E. S. Tillyer.

[The weights given are the *total* weights of the four wires; the resistances are those of each wire separately.—Eds. Elec. Rev.]

Commutator Bars.

Mr. Theodore Stevens may find the following useful, when making calculations from Messrs. Bolton's list of commutator sections:

$$\frac{2 \text{ width} \times 3{\cdot}1416}{{\cdot}001\,(t_1 - t_2)} = \text{No. sections.}$$

J. Stenson Haswell.

Leicester.

A NEW FORMULA FOR COAL ANALYSIS.

The empirical formula and the actual calorimeter give discordant results as the calorific capacity of a coal. The question is raised by M. E. Gautal, whether from the analysis of coal a formula can be given that will give a true calorimeter value. Dulong and Mohler based their calculations on the elementary analysis of coal, and they establish that the heating power of carbon remains constant, as does also that of hydrogen when in combination with the same proportion of oxygen and nitrogen. But the difficulty of analysis comes in and calls for very skilful chemists.

M. Gautal appreciates this, says Mr. Thomson, in a paper read at the recent convention of Canadian Electrical Engineers at Niagara Falls, and he reviews Mohler's work and has made many tests, and proposes a new formula. Coal analysis determines the coal in four sections; the determination of moisture, volatile combustible, fixed carbon, and ash. The formula is

$$Q = 14{,}670\ F\,C + A \times \text{volatile matter.}$$

Q is the calorific value, 14,760 is the value of fixed carbon, while A is a coefficient for volatile matter, and its value is 23,400 when A is from 2 to 15 per cent. of the total combustible matter. For 15 to 30 per cent., A = 18,000, for 30 to 35 per cent., A = 17,100, and for 35 to 40 per cent. it is 16,200.

The formula may be safely used up to percentages of bituminous matter 35 per cent. of total combustible. For European coals, Gruner divided them into five classes namely, where volatile matter composed 50 to 60 per cent. of total combustible; 60 to 68 per cent., 68 to 74 per cent., 74 to 82 per cent., and 82 to 95 per cent. Gruner's valuation is here given, and by adopting the principles underlying Gautal's formula, and multiplying by

Class.	Fixed carbon; % total combustible.	Volatile carbon; % total comb.	Hydrogen; % total comb.	Oxygen and nitrogen; % total comb.	Actual value in B.T.U.	Industrial value in B.T.U.	Industrial value; % of actual.
5	82	8	4·5	5·5	16,560	10,368	62·6
4	74	14	5·5	6·5	16,740	10,596	63·3
3	68	16	5·0	11·0	15,840	9,676	61·0
2	60	20	5·8	12·2	15,300	8,756	57·2
1	50	22	8·5	19·5	14,400	7,716	54·6

the average percentage of efficiency as determined by Scheurer-Kestner on European, and Johnston on American coals, the following formula is believed by the author to give fair results:—$Q = 14{,}652$ F.C. $+ A \times$ volatile matter $\times B$, where A has the values already given, and Q is the industrial value for steam purposes, and B is a coefficient relating to the relation of fixed carbon to total combustible, and has the following values $B = 0{\cdot}64$ for coals, in which the fixed carbon constitutes 82 to 90 per cent. of total combustible: ·65 where the carbon is 74 to 82 per cent., ·662 for 86 to 74 per cent., ·588 for 60 to 68 per cent., and ·551 where carbon represents 50 to 60 per cent. of the total combustible. Mr. Thomson believes that with this formula and a proximate analysis, can readily be determined the economic value of any sample of coal. If this be so the formula should prove fairly useful when corrected of course in final result for the relative proportion of ash present.

"ELECTRIC LIGHT BLINDNESS."

We make the following extracts from an exceedingly interesting article which appeared in the *Lancet* for July 24th from the pen of Robt. Hill, M.R.C.S., Eng., L.R.C.P., Lond., Surgeon Royal Navy (H.M.S. *Victory*), under whose notice the cases have lately come:—

"Case 1.—About 1 a.m. on June 1st, 1897, I was called hurriedly to see a man who was said to be suffering great pain in his eyes. The man, a stoker, 23 years of age, I found walking round the sick bay of this ship in an agony of pain, with his hands up to his eyes, from which the tears were literally pouring. The lids were kept firmly closed, and all my efforts to see the eyes proved futile until I had dropped in cocaine, which acted like a charm. Five minutes later he could distinguish the number of persons in the room, but not the number of fingers held up. The pupils were moderately dilated (probably due to the cocaine); the palpebral conjunctiva was deeply congested, with but slight reddening of the bulbar conjunctiva; the cornea was clear. I imagined some irritant had been applied, but he denied this, nor could I find any trace of any substance, such as pepper, likely to cause the condition. Cold applications were used and the patient soon fell asleep. At 8 a.m. his vision was normal, but the conjunctiva was injected, and he complained of a sticky sensation in his eyes. He then gave me the following history:—When at work in H.M.S. *Mars* on the afternoon of May 31st he had stopped for about three minutes to look at the electric drill which was being used to bore holes in a steel plate, standing at a distance of from 10 to 12 yards; on resuming his own work everything appeared to him of a deep gold colour, but he had no pain or lacrymation. He turned into his hammock at 9 p.m., and woke up in great pain at 12.30.

"Case 2.—At 9 a.m. on June 1st a stoker, aged 28 years, who had been sleeping on shore, came to the sick bay complaining of his eyes. He stated that he had been working in H.M.S. *Mars* on the previous afternoon, and like the patient in Case 1, had stopped to see the electric drill working, and had noticed during the remainder of the day that everything appeared of a deep gold colour. About 4 a.m. he had jumped out of bed in great pain, and this had lasted about an hour and a half. The condition of the eyes was very similar to that described in Case 1—injection of the conjunctiva being the only abnormal condition. Vision was normal."

Ever since the electric light has been in use workers at this trade have been subject to attacks of blindness, and cases have been recorded in which erosion of the cornea has followed the inflammation induced. Dark glasses are now always used by men so employed. The electric drill acts by fusing a hole through the steel, and probably the intensity of the light is greatly increased by the rays of light thrown off by the molten metal. The fact that the work is carried on chiefly in the daylight hides to a casual passer-by the extreme brilliancy of the light, and it is not until the patient experiences abnormal colour sensations that he is aware of anything extraordinary. When first this drill was used in Chatham Dockyard, Surgeon P. N. Randall had a few similar cases among the dockyard hands, but as they slept on shore, he had no opportunity of observing the acuteness of the pain.

A temporary paralysis of some of the optic nerve terminals is induced by the exposure to the intense light and heat of the electric drill as shown by the the subjective colour sensations experienced. The corneal terminals reflexly share in the paralysis; lacrymation and photophobia are absent because the nerve terminals are paralysed and not merely irritated at the time. After the lapse of a few hours a reaction with temporary congestion is set up as manifested by the acute pain and lacrymation, and probably some mistiness of vision. The longer the exposure to the bright light the profounder the paralysis and the more intense and lasting the reactionary symptoms. These cases are, in fact, analogous to snow-blindness, and, as in them, the pernicious effects of the electric light are probably due to the ultra violet rays of the spectrum.

INSURANCE COMPANIES' RULES.

We are indebted to Mr. A. Lester Taylor for copies of the following rules which have been adopted by the Fire Offices Committee for Electrical Power Installations:—

Rules for electro-motors and dynamos used in connection therewith of whatever size. Applicable to motors and dynamos introduced on or after July 22nd, 1897, in corn, textile, and oil mills.

1. Motors when not in an engine room or in a separate compartment expressly set apart for their use and built of or lined with incombustible material must be completely enclosed in an efficient metal case forming part of the designed construction thereof,

2. Resistances must be similarly situated or enclosed and constructed entirely of incombustible materials. They must be fixed against a brick or stone wall and not within 12 inches of any combustible material.

Note.—Inspection holes fitted with plate glass are allowed. Motors and resistances must be suitably designed to withstand without serious over-heating the effect of the absence of ventilation incidental to the use of a metal case. Ventilation, if any, must be only by direct communications with the outer air.

3. The motor pulley (or other mechanical device for transmitting power from the motor), must be external to the metal case enclosing the motor. Only the shaft and the connecting conductors may be carried through into the metal case or through the wall of the compartment. No belts, ropes, or other corresponding gear may be so carried.

Note.—Holes in the case to admit connecting conductors must have proper insulating bushings to prevent short circuiting.

4. Dynamos must be treated as motors.

5. Each motor and each dynamo must have a "switch" and a "cut-out" upon each of its connecting conductors.

6. Switches, cut-outs, and all other regulating and controlling devices must be made of incombustible materials only.

7. Fusible cut-outs not on main or distribution boards must have efficient incombustible covers.

8. All switches when not "on" must automatically turn full "off," and must work from "on" to "off" with a sharp break. The "break" in a switch or other disconnecting device must be of such a length that an arc cannot be sustained.

9. Connecting conductors must have their sectional areas so proportioned that, if of copper, the maximum working current must not exceed the ratio of 1,000 amperes per square inch of such sectional area for currents not exceeding 100 amperes.

10. Motors must not be supplied with current from dynamos or conductors having an earth return.

11. Waste oil from motor bearings and from dynamo bearings must be collected in suitable metal receptacles. Deep metal cans must be provided for oily waste for removal daily.

Rules for Electro-Motors exceeding ½ H.P., and not placed in a separate Compartment expressly set apart for their Use, and built of, or lined with, Incombustible Material.

Motors must be completely enclosed by a metal cover.

Inspection holes fitted with plate glass are allowed.

If the motor stands on a non-fireproof floor it must be placed on a sheet of metal of sufficient size to protect the whole of the floor within the cover.

The motor pulley, or other mechanical device for transmitting power from the motor, must be external to the cover. No belts, ropes, or other corresponding gear must be carried into the cover.

Holes in the cover to admit connecting conductors must have proper insulating bushes to prevent short-circuiting.

It is desirable to make the cover of rectangular shape, leaving the side through which the conductors pass as a fixture.

The above rules are applicable to all tariffs except corn, textile, and oil mills.

LEGAL.

Benn *v.* Electric and General Investment Company.

In the action which was recorded in the Electrical Review for June 11th of Charles E. Benn, a financial agent, carrying on business in America as well as in this country, against the Electric and General Investment Company, Limited, to recover £10,000 damages for breach of contract arising out of an alleged option in bonds, the plaintiff appealed to the Master of the Rolls and Lords Justices Smith and Rigby, on Tuesday, from the verdict and judgment of Mr. Justice Bruce and a jury, who heard the case in June last.

Mr. Sturgess, who now, as in the court below, appeared for the plaintiff, said the appeal was based on the holding of the learned judge that there was no evidence to go to the jury of the allegations contained in the plaintiff's statement of claim to the effect that in August, 1895, the County of London and Provincial Brush Electric Lighting Company, on behalf of and with the authority of the defendant company, agreed to issue certain bonds upon receiving a favourable report from the managing-director of the company.

Their lordships dismissed the appeal.

Gosling *v.* Gaskell and Grocott.

The House of Lords gave judgment on Tuesday in this appeal from a judgment of the Court of Appeal, affirming a decision of the Lord Chief Justice. Mr. Jelf, Q.C., and Mr. Hamilton appeared for the appellants, and Mr. Herbert Reed, Q.C., Mr. E. W. Hansell, and Mr. Gregson for the respondents. An action was originally brought by Messrs. Gaskell & Co., the respondents, manufacturers of electrical apparatus, at Longport, Staffordshire, against the appellants, Francis and Cunliffe Gosling, trustees for certain debenture holders in a limited company called Poole, White & Co., formerly electricians in the city, now in liquidation, to recover £488 odd, the price of goods alleged to have been sold to the appellants between December 5th, 1893, and January, 1895. The appellants denied their liability on the ground that as trustees to the debenture holders they had, under their powers, appointed a Mr. Kelly as receiver, who carried on the business as agent of the company, and that, therefore, the company was alone liable. They said in the alternative, that if it were held that the order winding-up the company in September, 1892, revoked their powers as trustees, then Kelly was personally liable. The Lord Chief Justice gave judgment for the respondents on the ground that, at any rate, since the winding-up in September, 1892, the appellants were the real principals. The appellants then appealed to the Court of Appeal, consisting of the Master of the Rolls, and Lords Justices Lopes and Rigby, who by a majority affirmed the decision of the Court below, being of opinion that Kelly was, in the circumstances, agent of the trustees, and that they were, therefore, liable to pay for the goods. Lord Justice Rigby dissented, hence the present appeal to the House.

The Lord Chancellor delivered judgment, reversing the order of the Court of Appeal. He was of opinion that the trustees were not the owners of the business, which was carried on ostensibly for and on behalf of the company, and that they could not, in the circumstances, be held to be principals. He thought the judgment of the Court of Appeal was wrong, and that this appeal should be allowed.

The other noble and learned lords concurred. The appeal was accordingly allowed, the respondents to pay the costs.

[A copy of Lord Herschell's judgment can be seen by anyone taking special interest in the case, at the Electrical Review Office.]

The Westminster Electric Supply Corporation *v.* MacCall with MacIntosh, Third Party.

In the Westminster County Court on Tuesday, before his honour Judge Lumley Smith, Q.C., this three-cornered action was brought to recover £3 5s. for electricity supplied.

The case for the Corporation was that the electricity was supplied to Iddesleigh Mansions under a contract with Colonel MacCall. He let the premises to MacIntosh, but the contract had never been terminated. Judgment was given against MacCall with costs, and judgment for MacCall against MacIntosh, with costs to include those in the Corporation judgment.

BUSINESS NOTICES, &c.

Artesian Wells.—It is interesting and satisfactory to know, especially when we remember the comparatively recent scarcity of water in London, that the supply of pure water in the future is likely to become more and more abundant and assured, owing to the increasing number of artesian wells which, year by year, are being bored throughout the kingdom. The Vestry of St. Mary, Newington, have adopted the artesian well system to supply the extensive and commodious Public Baths and Washhouses recently erected by them at Manor Place, Walworth Road, with the large amount of water daily required. One of the two wells which it was found necessary to bore has already been completed by the contractors, Messrs. Neill and Booth, of Pear Tree Street, Goswell Road, E.C., to a depth of 352 feet. On testing the yield of water at this depth, it was found to be fully 5,000 gallons per hour; this amount was obtained with only a small reduction of head in the borehole. Pumps are being supplied by the contractors, of their own make and special deep-well type, and much satisfaction has been expressed by the Vestry at the excellent result of the boring, which has fully borne out the forecast of those entrusted with the work. The water is fairly soft in character, and it will be a good water for steam boiler and laundry purposes. It comes from the flinty chalk, and its purity is assured by a thick overlying stratum of clay, through which no surface water can penetrate.

Electrical Wares Exported.

Week Ending July 27th, 1896.	£	s.	Week Ending July 27th, 1897.	£	s.
Alexandria. Teleg. mat.	32	0	Albany	57	0
Amsterdam	370	0	Bangkok	900	0
Barcelona. Teleg. cable	390	0	Bergen. Sub. cable	1,564	0
Berbica	11	0	Bombay	148	0
Boca	43	0	Buenos Ayres	306	0
„ Teleg. mat. ...	151	0	Callao	2,976	0
Brisbane. Teleg. mat.	150	0	Calcutta	512	0
Bombay	411	0	Cape Town	665	0
Brussels	22	0	Copenhagen	72	0
Buenos Ayres	462	0	Demerara. Teleg. mat.	32	0
„ Teleg. mat.	211	0	Durban	653	0
Cape Town	27	0	East London	135	0
Christiania. Teleg. wire	43	0	Fremantle	824	0
Colombo	123	0	Genoa	51	0
Durban	218	0	Gibraltar. Teleg. cable	3,000	0
Fremantle	243	0	Malaga	70	0
„ Teleg. mat.	293	0	Malmo	80	0
Gothenburg	550	0	Mauritius	10	0
Hong Kong	13	0	Melbourne	119	0
Kurrachee	18	0	„ Teleg. mat.	18	0
Malta. Teleg. mat. ...	111	0	Ostend	15	0
Marseilles. Teleg. mat.	17	0	Perth	658	0
Melbourne	12	0	Piræus	10	0
Monte Video	348	0	Port Elizabeth	168	0
Ostend	27	0	Rotterdam. Teleg. wire	56	0
Port Elizabeth	60	0	St. Petersburg. „	22	0
„ Said	8	0	Santander	14	0
Rangoon	62	0	Shanghai	294	0
Rio Janeiro. Teleg. mat.	820	0	Singapore. Teleg. cable	60,130	0
Rockhampton	324	0	Sourabaya	1,870	0
Rosario	1,258	0	Stockholm. Teleg. wire	159	0
St. Petersburg	8	0	Sydney	1,425	0
Santos	25	0	Vigo. Teleg. mat. ...	20	0
Shanghai	183	0	Wellington	523	0
Singapore	80	0	Yokohama	1,610	0
Stockholm	45	0	„ Teleg. wire	17	0
Sydney	32	0			
Wellington	2,283	0			
Yokohama	320	0			
Total	£9,804	0	Total	£106,233	0

Foreign Goods Transhipped.

	£	s.
Boulogne	220	0
Stockholm	56	0
	£276	0

Annual Outing.—The employes of **Messrs.** Walter V. Scott & Co., Limited, electrical engineers, of Cromwell Road, S.W., held their annual outing last Saturday at Windsor. Dinner was provided at the Bridge House Hotel, about 30 being present, the party having cycled down. The afternoon was spent on the river, and after tea a smoking concert was held at the residence of the managing director.

Blot Accumulators.—Mr. G. R. Blot announces that his French house has been formed into a limited company, to be known as the Compagnie des Accumulateurs Electriques Blot, with a capital of 1,600,000 francs. The offices will be situated at 39, *bis* Rue de Châteaudun, Paris. The directors are M. Jules Offroy, M. Octave Chemin, M. Henri Ehrmann, M. Henri Hénon, M. Charles Meyer, and M. Georges-René Blot.

Change of Address.—Messrs. John Davis & Son, of Derby, have removed their London offices from 118, Newgate Street, to 26, Victoria Street, Westminster, London, S.W.

Ediswan Lamps.—The Edison & S an United Electric Light Company, Limited, have issued an advance copy of a small portion of their Crystal Palace 1897 Exhibition pamphlet, which is to be published shortly.

Fire.—We learn that the works of the International Electric Storage Accumulator Company's works at Woking were destroyed by fire on Saturday morning last. The damage is estimated at £10,000. The actual cause of the fire is not known, but it is stated an explosion occurred at about the time of the outbreak. The above facts appeared in the daily press. We have received the following statement from the I.E.S. Accumulator Company:—"Referring to notices which appeared in the evening papers of Saturday, the 24th inst., respecting a fire which took place at our works at Woking on that day, the following are the facts:—The outbreak occurred about 5 a.m. in the drying room from an unknown cause, and was followed by a slight explosion, cause of which is also unknown; the fire afterwards spread to casting shop in same building, which was speedily reduced to ashes. The damage consists of destruction of casting shop, drying room, and loss of a considerable number of plates. The interruption to business will be very slight, delay only being in execution of orders for plates which were destroyed in drying room."

Gas.—A serious gas explosion took place at Deacon Road, Kingston-on-Thames, on 25th inst.

Haywood v. Carlton, Hessey & Co., James Carlton, Sen., The Madeira Electric Lighting Company, Limited, and Beazley.—The plaintiff in this action, Mr. Alfred Haywood,

of 97, Finsbury Pavement, sued the several defendants at the Lord Mayor's Court to recover the sum of £2,333 6s. 8d., being one-third share of a profit of £7,000 received by the defendants, or some of them, upon the flotation of The Madeira Electric Lighting Company, Limited, which amount, it was alleged, the defendants verbally agreed to pay the plaintiff in consideration of his having introduced the business. Dr. Blake Odgers, who appeared for plaintiff, in the course of the case admitted that his client had no claim against The Madeira Electric Lighting Company, Limited, and Mr. Josiah Beazley, and the Recorder, in directing a verdict to be entered for them, said it was scandalous that they had ever been entered as defendants. Mr. W. J. Farmer was called on behalf of the plaintiff, and in reply to Dr. Blake Odgers, said Messrs. Carlton, Hessey and Co, and Mr. Carlton, Sen., were introduced to him by Mr. Ernest Beazley. He had seen the plaintiff many times previously, but not relative to the introduction. He floated the company. The Recorder said this witness's evidence put the plaintiff's case out of Court. Dr. Blake Odgers said he could not carry the case any further, and a verdict was consequetly returned for the defendants.

Lists.—Messrs. J. C. Lyell & Co., of Victoria Street, S.W., have sent us one of their latest lists of Berne carbons for arc lamps, batteries, dynamo-brushes, smelting carbons, telephones, incandescent lamp filaments. These carbons are of the Carré make, and those used for arc lighting are claimed to be very tenacious and rigid, to burn more evenly, and give much greater light than some other makes.

Messrs. J. E. Spagnoletti & Crookes, of Goldhawk Road, W., send us illustrated lists of their ceiling roses for high voltage circuits, tumbler pattern "G. S." switches, and distributing switchboards. Prices for the various sizes are given.

Liquidation Notices.—A general meeting of members of Lawrence, Scott & Co., Limited, will be held at Gothic Works, Norwich, on August 24th, at 3 o'clock p.m., for the purpose of having an account of the winding-up operations laid before it.

At meetings of the Westralian Electric Lighting and Supply Company, Limited, held on June 23rd and July 9th, at 54, Old Broad Street, E.C., resolutions were passed winding up the company voluntarily for the purpose of reconstruction, and appointing Mr. G. H. Homan liquidator. A new company with the same title is to be registered, and a draft agreement was approved at the meetings, the liquidator being empowered to carry same into effect.

North Country Notes.—Since the reduction by the Edinburgh Electric Supply Corporation from 5d. to 4d. per unit, considerable activity has been given to the electrical trade in that district. The Scottish Conservative Club is going to be entirely re-wired and refitted with artistic fittings. This has been placed in the hands of the Tayler Smith Electrical Company, who are also carrying out a very large number of private installations in Edinburgh, including that for the Right Hon. J. Blair Balfour. The Tayler Smith Electrical Company have opened premises at 77, George Street, Edinburgh, in connection with their London business.

Phosphor Bronze.—We have received a copy of the fourth edition of the Phosphor Bronze Company's new list of phosphor bronze, "Duro metal," silicium bronze, Bull's metal, "melloid," and white metals.

Reduction of Capital.—It is notified in the *London Gazette* that a petition, presented on July 10th, for confirming a special resolution reducing the capital of the Westminster Electric Supply Corporation, Limited, from £400,000 to £399,500, is to be heard before Mr. Justice Stirling, in the Chancery Division, on August 7th.

Salmony v. Lawrence & Butler.—In the Westminster County Court on Thursday last week, his Honour Judge Lumley Smith, Q.C., tried the case of Salmony *v.* Lawrence & Butler, in which the plaintiff firm, who are electrical engineers carrying on business at 120, Charing Cross Road, sued the defendants, who are dealers in electrical fittings, carrying on business at Stafford Street, Bond Street, to recover the sum of £36 in respect of electrical fittings supplied to their order. The defendants admitted the claim subject to a deduction for certain goods which was alleged to have been supplied on sale or return, and set up a counter-claim for damages in respect of a number of electric holders which were found to be defective. The defendants' case was that they had a contract to fit up the electric light at the premises of Messrs. Crosse & Blackwell, and went to the plaintiffs for fittings. A large number of the goods were found to be defective, and the result was that there was a loss to the defendants of about £25 in labour over and above the extra cost of purchasing other goods elsewhere. After hearing the evidence his Honour said he was satisfied that the plaintiffs supplied goods which were defective in quality, and after taking into account the loss which the defendants had thereby suffered, and allowing for goods which had been supplied on sale or return, there would be judgment for the plaintiffs on the claim for £20, and judgment for the defendants on the counter-claim for £15 by way of damages, each party to pay their own costs.

Sunderland Exhibition.—The Sunderland Engineering, Mining, Electrical, Marine, and General Trades Exhibition, opens in November, 1897. Forms for intending exhibitors, plans of the buildings, and general prospectus, are now being circulated. In the Electricity Department there are 15 sections. Particulars as to space from the secretary, Exhibition Offices, Fawcett Street.

The Engineers' Strike.—Messrs. Saxby & Farmer, Limited, ask us to contradict reports which have been circulated to the effect that their men are on strike. All are working as usual, and the execution of orders is in no way interfered with.

To Brussels.—Nearly everyone is thinking about holidays just now, regarding them either from the pedestal of reflection or anticipation. To those who belong to the latter fortunate class, and who have not yet fixed upon a congenial resting place, we recommend a small sixpenny book on "Walks in Belgium, with Brussels and its Exhibition," by Percy Lindley.

ELECTRIC LIGHTING NOTES.

Ashton.—At an extraordinary meeting of the Electric Lighting Committee on June 29th, a letter from the Local Government Board was read with reference to the application of the Town Council for sanction to borrow £34,500 for electric lighting purposes and £1,750 for the erection of a refuse destructor, and stating that an inquiry would be held shortly. The Town Clerk submitted correspondence between himself and the Horsfall Furnace Syndicate, Limited, and reported an interview with the managing director of the syndicate in reference to certain alterations and modifications which the syndicate desired to have made in the draft contract between themselves and the Corporation for the erection of a refuse destructor. It was resolved that the Town Clerk be instructed to agree to certain modifications as suggested by him and approved by the engineers, Messrs. Fawcus & Clirehugh.

Bedford.—A Local Government Board inquiry was held on 28th inst. *re* Council's application for sanction to the borrowing of £20,000 for purposes for electric lighting.

Cardiff.—The Corporation of Cardiff are going to employ a local consulting engineer to periodically inspect the several steam boilers belonging to the Corporation. Salary, £80 per annum.

The Electrical and Lighting Committee appointed a clerk and collector for the electric lighting account business on Monday.

Deptford.—It has been resolved to allow the Deptford Baths Commissioners to borrow £2,200 to defray the cost of the installation of the electric light at the Deptford Baths and Washhouses.

Dorking.—The Special Committee appointed by the District Council to consider the question of street lighting report that, Messrs. Edmundson, Limited, have submitted a scheme of the works they propose carrying out should the Council's provisional order be transferred to them, but before recommending the acceptance of the terms offered the Committee desire the scheme to be examined by an independent engineer. The Council have engaged Mr. F. J. Warden Stevens for that purpose.

Dover.—On Saturday last the Hotel Burlington was formally opened by Mr. Henniker Heaton, M.P., in the presence of the Mayor and many other invited guests, for whom an excellent luncheon had been provided. The hotel is a really splendid building, furnished by Maple & Co., and lighted throughout by electricity, current being supplied from the mains of the local electric light company. There are in all about 1,099 lamps of various candle-power in use, the wiring being equivalent to 2,200 lamps of 8 C.P., all the work having been executed by Mr. Leo Sunderland as resident engineer for the contractors, the Brush Electrical Engineering Company, Limited. Wood casing is used, and the rising mains are in duplicate as a safeguard, the main switches being of the Burbey and Hutton make. Bells and indicators are fitted throughout.

Dundalk.—A committee of the Town Commissioners, assisted by Mr. Porte, electrical engineer, has had under consideration the terms of the proposed arrangement with the electric tramway syndicate for the lighting of the town by electricity. A Dublin paper says that they have decided to recommend the Commissioners to offer a certain fixed price for the complete public lighting of the streets of the town. The Electric Lighting Provisional Order which the Commissioners have obtained, and which has just received the Royal assent, is to be transferred by them to the syndicate. The order in Council authorising the construction of the electric trams has not yet been reported to Parliament. Should it pass this Session, work may be commenced next spring.

Edinburgh.—The Electric Lighting Committee have finally adjusted their estimates for the year to May 15th, 1898. The expenditure was estimated at £18,920, as against an estimate of £10,730 last year, and an actual outlay of £21,419 18s. 8d. The receipts for next year were estimated at £34,155 or thereby, as compared with last year's estimate of £23,850, and an actual of £26,828 10s. 11d The same committee estimated their capital expenditure for the next year at £46,900.

Ferndale.—The Rhondda District Council is asking the Ferndale Electric Lighting Company what it will charge for lighting certain streets electrically.

Hammersmith.—The Vestry is printing 250 copies of a complete description of the electric lighting installation, prepared by the Surveyor and Consulting Engineer.

Huddersfield.—The Board of Guardians has decided to obtain estimates for the lighting of the Union offices by electricity.

Liverpool.—At last week's meeting of the Lighting Committee it was reported that on June 30th the number of 16 C.P. lamps connected with private lighting in the city was 52,518, and for Corporation purposes 4,818, making a total of 57,336, being an increase of 630 lamps on the month. The number of units supplied during June was 72,942 for private use, and for the Corporation 14,271, making a total of 87,213, as against 44,841 in the corresponding month of 1896. It was resolved to extend the electric supply to Granby Street and the immediate neighbourhood.

Maerdy.—The District Council is asking the Electric Light Company to state definitely when it will be prepared to light the roads electrically, assuming terms were arranged.

Paisley.—Messrs. Callender's Cable and Construction Company, Limited, have now commenced laying the electric light mains in connection with the municipal electric lighting scheme. The work is to be supervised by their chief engineer, Mr. W. Douglas Reid.

Portobello.—The Edinburgh Cleaning and Lighting and Electric Light Committees has resolved to recommend the introduction of the light into Portobello on the lines laid down in Prof. Kennedy's report.

Reigate.—At a meeting of the Town Council on Monday, the Electric Lighting Committee recommended the Council, when Royal Assent be given to the Bill confirming the provisional order, to carry out the works necessary to light the compulsory area themselves, and to invite tenders for the work. It was resolved to have Mr. Medhurst, the engineer, before a committee of the whole Council, in order that some information as to the working of the light in other towns might be ascertained.

Rowley Regis.—The South Staffordshire Blast Furnace Power Syndicate are about to establish electric lighting works at Rowley Regis with the object of providing electric light and energy for the adjacent towns.

Sunderland.—The borough accountant has issued his annual report. The total expenditure for the year over the electric light is £3,662, while the income is £2,714. The whole charges incurred in actually generating and distributing electricity reach £1,993. This includes £287 for rent, rates and taxes, and the £1,669 required to balance the £3,662 has been paid away for interest on the original capital (£872) and towards purchasing the property and plant (£749).

The Embankment Lighting.—At the London County Council, last week, reporting on the decision of the Council to light the Embankment and bridges by electricity, the Highways Committee recommended that they should be authorised to invite tenders by public advertisement for the erection of the generating station, and for the supply of the necessary machinery, mains, lamp standards, and other plant for the installation. Upon the reception of the report, Lord Mountmorres asked whether it was proposed to retain the gas lamps on the Embankment wall. He hoped they would do so, because the line of the lights was at night one of the prettiest sights in London.—Lord Russell (Chairman of the Committee) said he could not say.—Lord Mountmorres then moved that the report should be referred back.—Mr. Fletcher seconded, and said he hoped that electricity would be substituted for gas on the wall. At present, the gas which escaped from the pipes through the soil was slowly killing the trees. The gas companies might place their mains in the subway, but they refused to do so, and the Council had no power to make them.—Mr. Yates protested strongly against any generating station being placed upon the Embankment. Such stations, he declared, were worse to live near than the noisiest railway.—Mr. Alderman Dickenson said there was nothing the Council's reputation depended upon more than their treatment of the Embankment. He was convinced that if they lighted the Embankment in the way proposed they would regret it. The chimney of the generating station would have to be higher than the top of the railway bridge at Charing Cross, and, if that were to be an accomplished fact, they would have the whole press of London condemning them. Mr. E. JONES objected to any further postponement. The matter, he pointed out, had been discussed for the past four or five years, and if the members did not know what they wanted now they never would.—The Council, by a large majority, referred the matter back to the Committee.

Yarmouth.—The electric light receipts for June were £169 6s. 8d., meeting the working expenses and leaving a surplus of only £13 18s. 8d. to meet a monthly capital charge of £170. The surveyor, in a series of explanations, professes his belief that at the end of the year the balance on the wrong side will be only £400. As to the position of the undertaking, £30,228 had been spent out of £35,000 sanctioned, but the balance will be required to pay outstanding debts, &c. Since 1895 the undertaking has been on the wrong side to the tune of £1,492, which has been provided from the rates; but of this amount £1,423 has gone in re-payment of capital, and in 25 years, the surveyor says, the works will have been paid for. He estimates, he states, that the loss for the first two years would be £1,500, and he is disappointed that his anticipation of the success of the venture in the following year has not been realised. For the further satisfaction of the ratepayers, he says that the plant can supply 12,000 lights, and when all the sanctioned loans are spent 16,500. At present less than 10,000 are being supplied, and as the staff is quite equal to producing the maximum, he thinks the earning power of the works will be doubled as soon as all the lights are taken.

ELECTRIC TRACTION AND MOTIVE POWER NOTES.

Blackpool-Fleetwood.—The construction of an electric tramroad along the coast from Blackpool to Fleetwood was commenced on last Monday last week. The line is expected to be ready for traffic next summer, when there will be a tramway along the whole of the Fylde seaboard from Lytham to Fleetwood, a distance of 16 miles.

City and South London Railway Stock.—Those taking an interest in the underground electric railway work now in hand in London have probably asked the same question as does "Stockholder" in the following letter to the *Financial News*: "How is it that the ordinary stock of this most promising and extremely well managed railway company stands at the present low price of 64? The yield at this price, based on the dividend recently declared is about 3¼ per cent., which, in itself is extremely satisfactory; but now that the extensions to Finsbury and to Clapham are well under way, one cannot help being surprised, and, as a shareholder, somewhat disappointed that the stock remains at so low a price, especially with Great Easterns at 120 on a 2 per cent. dividend. If the public only knew more about the company and what it is doing, I am sure this anomaly would not long exist."

Dudley and Stourbridge.—An extraordinary general meeting of the Dudley and Stourbridge Steam Tramways Company, Limited, was to be held at the Grand Hotel, Birmingham, yesterday, when the subjoined resolution was to be proposed:—"That the agreement for the sale of this company's undertaking to the British Electric Traction Company, Limited, dated April 30th, 1897, and made between this company of the one part, and the said British Electric Traction Company, Limited, of the other part, be and the same is hereby approved, ratified, and confirmed."

Leeds.—Sir F. A. Marindin, of the Board of Trade, inspected the permanent way of the electric tramways from Roundhay to Kirkstall on Friday last. The Board of Trade inspection of the electrical equipment was to take place early this week.

Liverpool.—On Monday, the draft report with reference to the experimental application of electric traction to tramways on the overhead trolley system was approved by the Special Tramways Committee, with a few slight alterations.

Light Railways.—The London County Council, on Tuesday, approved a report submitted by the Parliamentary Committee, stating that they had considered the Corporations application to the Light Railway Commissioners. We make the following extracts:—"The Corporation of London are seeking powers to construct two railways, one of which is to connect the Deptford goods depôt of the London, Brighton and South Coast Railway Company with the Foreign Cattle Market at Deptford, and will consist of a railway which will be three furlongs in length, and the principal portion of which will be placed along the surface of Grove Street. The other railway which it is proposed to construct will connect the Deptford Goods Depôt of the London, Brighton and South Coast Railway Company with this company's wharf on the opposite side of Grove Street, and will consist of a level crossing. The second railway is practically identical with a scheme put forward by the Brighton Company in 1896 Session, but afterwards withdrawn in consequence of the opposition of the Council and the local authority At that time the objection of the Council was to the creation of a level crossing. What is now proposed is that a railway should be allowed to run along the surface of the streets to a distance of over three furlongs. The railway may be constructed as single, double, or interlacing lines, and the gauge is to be such as the Corporation may determine, subject to approval of the Board of Trade. It may be worked by 'animal, steam, electrical, or such other approved mechanical power as the Corporation may from time to time think fit.' If electric traction is employed, the Corporation may place and maintain in the streets posts, brackets and overhead wires. This is to be done without consent of the Council, which is required under the Electric Lighting Acts, but that of the Board of Trade and the District Board must be obtained. It is provided that the consent of the latter shall not be unreasonably withheld. Clause 7 permits the Corporation, amongst other things, to make, maintain, and erect all such sidings, junctions, &c., boxes, cables, posts, batteries, dynamos, transformers, accumulators and engines, &c., as they may from time to time think fit, and also authorises them for this purpose to open and break up any such street or road, and any sewers, drains, &c., therein. These two clauses are to a certain extent limited by clause 19, which is an ordinary standing safety clause for electrical power, and gives no special protection to the Council or the district." The Committee state that "the proposed order appears to us to be contrary to the intention and spirit of the Light Railways Act, and to involve entirely novel methods of using the streets of London, contrary to any principle laid down by past legislation, and such as we think it to be the duty of the Council strenuously to resist. Having regard to clause 9 of that Act, we are of opinion that objection should be taken to the proposed order on the ground that the undertaking is one which ought not to be sanctioned by an order of the Board of Trade, but should be submitted to Parliament. The powers sought practically amount to indirectly granting to a railway company the right to extend their system by use of the streets, and they would allow of the carriage of miscellaneous goods in trucks drawn by an ordinary locomotive steam engine or by electric traction by means of overhead wires. It is an abrogation of the long-established rights of the road authorities, and of the Council as the tramway authority. Seeing that the tramway system is now passing

into the possession of the Council, while it is admitted that large extensions of that system are desirable in the interests of the public, we feel that the Council will generally agree that nothing should be done to interfere with such extension, nor do we think it was the intention of the legislature to deprive the ratepayers and the travelling public of London of the legislative protection secured to them by the Tramways Acts. We may remind the Council that the Light Railways Act was originally justified as a means of affording cheap carriage through the agricultural districts, but the conditions of traffic in such districts are entirely dissimilar from those in a crowded city, and we think the Council is entitled to claim that no concessions under this Act should be given except to the representative and responsible authority. We regard this proposal as involving a most dangerous precedent, and having consulted the chairman of the Highways Committee, which has already reported to the Council on the subject, we recommend: 'That the Parliamentary Committee, in conjunction with the Highways Committee, be instructed to oppose the order.'"

Rail Bonding.—With the title of "Rail bonding and the protected rail bond," the Forest City Electric Co., of Cleveland, O., have issued a small pocket-book which goes into the question of the necessity for good bonding, and describes briefly, with the aid of illustrations, some of the methods which have been used from the early days of electric tramways in the States. The protected rail bond, the improved Cleveland bond welder, are described in an interesting manner. Though dealing with the subject for the company's own purpose, the book is exceedingly useful, and is got up in an interesting manner. Another pamphlet issued by the Forest City Co. describes the roll drop and drop forged commutator bars. A table at the end of this list shows the divisions of commutators.

TELEGRAPH AND TELEPHONE NOTES.

Telegraphic Interruptions and Repairs:—

Cables.	Down.	Repaired.
Brest-St. Pierre (Anglo, 1869)	April 6th, 1893 ...	...
West Indies—		
St. Croix-Trinidad	... Nov. 30th, 1896 ...	...
Cayenne-Pinheiro (Brazil)	July 22nd, 1897 ...	...
Amazon Company's cable—		
Parintins-Itacatiara	... May 5th, 1896 ...	...
Obidos-Parintins	... Dec. 7th, 1896 ...	...
Zanzibar-Mombassa ...	... July 13th, 1897 ...	...
Accra-Kotonon ...	... July 15th, 1897 ...	July 24th, 1897.
Capetown-Mossamedes	... July 19th, 1897 ...	July 28th, 1897.
Cyprus-Latakia ...	... July 23rd, 1897 ...	...
Aden-Zanzibar ...	... July 28th, 1897 ...	...
Communication to Vancouver	July 24th, 1897 ...	...
Landlines.		
Trans-Continental line beyond Masol	March 12th, 1896 ...	...
Carthagena - Barranquilla (Columbia)	July 4th, 1896 ...	...
Saigon-Bangkok ...	... July 22nd, 1897 ...	July 28th, 1897.
Siberian landlines—		
Tschita-Nertschensk	... July 24th, 1897 ...	July 25th, 1897.

April 19th, 1897.—Chio-Syra route impracticable.

April 19th, 1897.—During war between Turkey and Greece, cable between Trieste and Corfu cannot be used for messages for Turkey; they must be sent *vid* Bosnia, Montenegro and Servia.

The Ottoman Government announces that messages in secret language may not be sent to the Greek Minister and Consul in Turkey. They are to be sent in plain language.

April 21st, 1897.—The Greek Administration prohibits secret language for private telegrams for Greece.

April 25th, 1897.—The Hellenic Administration notifies delay on press messages emanating from Greek provinces by reason of the lines being blocked.

May 26th, 1897.—The Ottoman Administration notifies that, until further notice, private telegrams for Crete must be written only in plain Turkish or French language.

River Plate Telegraph Company.—In the Commons last week Mr. Renshaw asked the Under Secretary of State for Foreign Affairs whether the River Plate Telegraph Company, Limited, a British company with lines between Buenos Ayres and Monte Video, has, through no fault of its own, had its entire service suspended by the Argentine Government since January 30th last, whilst a native opposition telegraph company has been permitted to continue working. Mr. Curzon replying said that the circumstances are as stated by the hon. member. Her Majesty's representative at Buenos Ayres has been instructed to use his best efforts for the recognition of the just rights of the company; and it is hoped that the representations which it has been his duty to make may suffice for that purpose.

The Aden-Zanzibar Cable.—The Eastern and South African Telegraph Company announced a few days ago the interruption of its Aden-Zanzibar cable. The wire between Mossamedes and Cape Town having been broken for the past week, this new interruption cuts off telegraphic communication with South Africa, Zanzibar, Seychelles, Mauritius, Mozambique, Madagascar, and Lourenco Marques. The daily press says "The interruption on the African West Coast is close to Cape Town, and as the ship arrives there on Saturday, it will probably be repaired on Sunday or Monday, and communication restored between Europe and the Cape. Another ship has left for the repair of the East Coast line."

The Postal Telegraph authorities, on Wednesday, gave notice that the Cape Town cable, which was interrupted for some time on Tuesday afternoon, had been restored, and that South Africa could be reached *viâ* the West Coast.

CONTRACTS OPEN AND CLOSED.

OPEN.

Carlisle.—August 12th. The Corporation want tenders for boilers, mechanical stokers, dynamos, storage battery, switchboard, boosters, arc lamps, feeders, mains, &c., for the electric lighting undertaking.

Hampstead.—August 5th. The Vestry want tenders for the supply of best Welsh smokeless or other coal to their electric lighting station, Lithos Road, Finchley Road, N.W., for one or three years from September 29th, for the Vestry of St. John, Hampstead. Specification and forms of tender may be had, and further particulars obtained, at the Vestry Hall.

Hapton (Lancs.).—August 2nd. Tenders are invited for lighting the township with electricity from September 1st to April 30th. Particulars from Mr. Ed. O'Shaughnessy, clerk to Hapton Parish Council, St. Anne's Terrace, Padiham.

Islington.—August 5th. The Vestry want tenders for the installation of electric light at Caledonian Road Baths, Caledonian Road, London. Particulars from Mr. A. Hessell Tiltman, Architect, 6, John Street, Bedford Row, W.C., on payment of £2 2s. (returnable.)

Ludlow.—September 1st. The Corporation of Ludlow offers a prize of £20 for the best and most economical scheme of electric lighting for the borough. Town Clerk, Mr. John Herbert Williams. Should the Corporation employ the engineer whose scheme is awarded the prize to carry the work out, then the £20 will merge in commission.

Manchester.—The Town Hall Committee of the Manchester Corporation are prepared to receive tenders for electric light fittings for the Hulme Town Hall. Particulars on application to Mr. Rison, Town Hall, Manchester.

Newport.—July 30th. The Electric Lighting Committee invite tenders for the supply and erection of boilers, mechanical stokers, and other apparatus for the boiler house plant, steam alternators and exciters, accumulators, steam and exhaust pipes, switch gear, arc lamps, posts, &c., coal elevator and "allowance for day-load plant." Consulting Engineer, Mr. Robert Hammond.

Oldham.—August 6th. Tenders are invited for the construction of the permanent way of about eight miles of the Oldham, Ashton-under-Lyne, Hyde and District electric tramways, for the Oldham, Ashton-under-Lyne, Hyde and District Electric Tramways Company. Specifications, plans, quantities and form of tender may be had on deposit of £5 which will be returned on receipt of a *bonâ fide* tender, from the Secretary. Tenders endorsed "Tender for Oldham, Ashton, Hyde and District Tramways Permanent Way," are to be delivered to Mr. C. Walmsley, Secretary to the British Electric Traction Company, Limited, 1 and 2, Great Winchester Street, London, E.C., by 12 noon on August 6th.

Port Elizabeth.—September 21st. The Town Council invite tenders for lighting the streets and municipal buildings of Port Elizabeth by electricity in consideration of the grant of a concession for the exclusive right of supplying electric current through the streets and roads of the town to private houses, stores, &c., for terms of 5, 15, 20, 25 or 30 years respectively.

Roumania.—August 20th. Tenders are being invited by the General Direction of the Roumanian Posts and Telegraphs in Bucharest for the supply of 55,000 porcelain (double-bell) insulators. Tenders to be directed to the Direction Générale des Postes et des Telegraphes, Bucharest.

Russia.—November 1st. The Municipal Authorities of Novorossisk, South Russia, are inviting tenders for the concession for the construction and working of an electric tramway and for the electric lighting of the town.

Sedgfield.—August 7th. The Durham County Asylum Visiting Committee want schemes and specifications for the electric lighting of Winterton Building at Sedgfield Asylum, 500 to 560 16-C.P. being required for that structure and a greater number for the main building. Particulars from Mr. Crozier, County Engineer, Shire Hall, Durham.

Sofia.—September 22nd. The Secretary of State for Foreign Affairs has received a despatch from the Acting British Consul-General at Sofia, stating that the municipality of that town invite tenders for—(1) The supply of electric current to light the streets as well as public and private buildings in the town and the supply of electric power; and (2) The construction and working of electric tramways in the town and suburbs. Tenders will be received at the offices of the municipality of Sofia. Such further particulars as have been received may be seen at the Commercial Department of the Foreign Office any day between the hours of 11 a.m. and 6 p.m.

Spain.—August 5th. Tenders are being invited by the General Direction of the Spanish Posts and Telegraphs for the supply of 14 tons of copper sulphate for the telegraph service. Tenders to the Direccion General de Correos y Telegrafos, Madrid.

St. Pancras.—August 9th. Tenders for the supply of Welsh and other steam coal for use at the Regent's Park and the King's Road electricity stations for nine months, for the Vestry of St. Pancras. Average about 100 tons per week. Particulars upon application at the Electricity Department Offices, 57, Pratt Street, Camden Town, N.W.

Switzerland. — September 25th. Tenders are being invited by the Municipal Authorities of Lausanne for the concession for the establishment and working of a central electricity supply station in the town. Tenders to be sent to, and particulars may be obtained from, Le Conseil Municipal de Lausanne.

CLOSED.

Austria.—Messrs. Ganz & Co. of Budapest have secured a contract for the establishment of a central station in the Government Arsenal in Vienna, for electric lighting and power purposes.

France.—The French Post and Telegraph Authorities in Paris lately called for tenders for the supply of 755 kilometres of paper-insulated electric cable, in sixteen lots. Fourteen of the lots have been secured by Messrs. Aboilard & Co, Paris, and two by the Société Industrielle des Telephones, Paris.

Paisley.—At a meeting of Council last week, the Electric Lighting Committee's recommendations to accept the following offers were confirmed:—Two boiler feed pumps (Cameron type) Messrs. P. and W. Maclellan, Glasgow, at £71 each. 61 arc lamps pillars, Messrs. Walter Macfarlane & Co., Glasgow, at £10 17s. 6d. each. Transformers, Messrs. The Brush Electrical Engineering Company, Limited, London. The Electrical Engineer is Mr. Francis Teague.

AN INFORMAL CONFERENCE.

It is with a certain amount of curiosity that we await the promised official publication of the views interchanged between the various Colonial Premiers, who have recently visited this country, and Her Majesty's Secretary of State for the Colonies. As to the feeling of loyalty to Her Majesty, and of affection for the land from which they sprung, there is no lack of convincing evidence. Apart, however, from matters of sentiment, it will be interesting to learn how far such a gathering of representative men has been useful in bringing to any practical issue the questions which, in England, have been regarded as of first importance as far as the mutual relations between Great, and and Greater, Britain are affected.

With such an idea before us, we are somewhat concerned to find a statement in the daily Press, which carries with it an air of authority, and from a perusal of which we gather the impression that the only definite conclusion arrived at was "that it would be wise to hold periodical conferences between the Prime Ministers and the Secretary of State for the time being" at intervals "of say three or four years, or oftener if necessary," these to be held in London. The point which interested us most, amongst the inconclusive conclusions arrived at (according to the statement above referred to) was that "the Conference left the Pacific cable scheme in mid-air," a position in which it is presumably certain to be well ventilated. It is difficult to appreciate the reason given for thus dealing with a subject which has already been favourably reported upon by the Colonial Conference held in London in 1887, and the Colonial Conference held in Ottawa in 1894, and which, according to the "statement" with which we are dealing, "had been referred to a Commission representing Great Britain, Canada, and Australasia," "which Commission had reported favourably upon the scheme for laying an all-British cable from Vancouver *via* Fanning Island to Fiji, bifurcating thence to Australia and New Zealand." We find it stated as a reason against the laying of a cable between Canada and Australasia, that the Eastern Extension Telegraph Company have proposed to lay an "all-British line from Western Australia across the Indian Ocean to Mauritius, thence connecting with the Cape and St. Helena and Ascension." We must confess that after careful study we cannot see how this proposal can in any way affect the proposed Pacific cable scheme. We can quite realise that it is absolutely necessary to improve the present unreliable means of telegraph communication with the Cape, and it is known that for strategic reasons a cable from the Cape to England, *viâ* St. Helena and Ascension, would be welcomed by the Admiralty and the War Office; the interest of the Post Office is not so obvious. In any case it is clearly to the interest of the Eastern Extension Telegraph Company to remedy, as far as may be, the frequent interruptions which occur in communication with South Africa. It is now a matter of history that amidst a series of cable breaks closely following each other, Mr. Chamberlain was fortunate enough to get a telegram through to the Cape, which saved this country from most disastrous consequences. Even during the current week, although it may not be generally known, we have been completely isolated from South Africa, the cables on both the East and West Coasts having been totally interrupted. A repair made on Wednesday last has, however, allowed of telegrams being sent along the West Coast of Africa. Apart from other reasons, it is incredible that a prolongation of such an inefficient system to Australia should be seriously suggested as an alternative to a cable across the Pacific. We find on inquiry that since the time of the troubles in the Transvaal, less than two years ago, the cables on which we rely for our telegraph information with the Cape have broken down at least 15 times, and that the total period during which they have been interrupted is 24 weeks, or nearly six months. There are two cable routes to the Cape, one along the East Coast, the other along the West Coast of Africa; but as regards the share of each route, both as to frequency and duration of interruption, there is nothing to choose. We can only be thankful that both these routes have not been more frequently interrupted simultaneously.

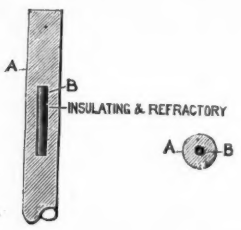
NOTES.

City and Guilds of London Institute.—At a meeting of the Council of the City and Guilds of London Institute, held on Monday afternoon, the diploma of "Associate of the City and Guilds of London Institute" was conferred on the following matriculated students who have this year successfully completed a full course of instruction at the City and Guilds Central Technical College:—

Civil and Mechanical Engineering.	Applied Physics and Electrical Engineering.	Applied Chemistry.
Hanbury, H. W. (Siemens's Medal).	Marchant, E. W., B.Sc., (Siemens's Medal and Premium).	Silvester, F.
Cornish, J. E.	Waters, W. L.	Lessels, G.
Unwin, W. P.	Spiers, F. S., B.Sc.	Crosskey, A. N.
Drury, H. D.	Twyman, F.	Jessop, F. J.
Willis, J. B.	Brown, E. G.	Winch, H. J.
Jacomb-Hood, M.	Grant, S. S.	Nind, E. R.
Malim, J. C.	Lean, C.	Devas, E. W.
Lewis, A. W.	Kirkby, H. M.	
Solomon, R. S.	Sayers, R. M.	
Williams, H. J.	Barker, W. E.	
Rich, T.	Nelson, W. M.	
Shackle, C. E.	Smith, S. L.	
	Mott, H. R.	
	Kerr, T. A.	

Cowper-Coles' Process for the Manufacture of Parabolic Reflectors.—Up to the present time glass has been the material exclusively used for the manufacture of parabolic reflectors for search lights, as it was found impossible to get the required surface and stiffness with spun, stamped, or cast metal moulds. Another difficulty was also experienced in getting a suitable metal that would not tarnish under the trying conditions of an enclosed arc lamp. We are informed that parabolic mirrors made by the Cowper-Coles process have recently been tested with most satisfactory results. In this process the moulds are made of or covered with wax which is polished by friction. On this surface a layer of silver is deposited chemically, and also polished. A film of palladium is next put on to the silver by means of an electrolytic bath, and finally the whole is backed with copper, thrown down as rapidly as possible at first by the aid of a powerful current, the object being kept in motion the while. The mould is then removed, and the reflector either heated so as to cause the silver and palladium to alloy, or the former is dissolved away by the action of potassium cyanide.

Smith's Cut-out Arc Carbon.—In spite of the fact that arc lamps are provided with automatic cut-outs to protect the lamp in case the carbons burn too short, the fact remains that carbon holders are frequently destroyed owing to the failure of the cut-outs to operate. This is especially the case, says the New York *Electrical Engineer*, with enclosed arc lamps or single carbon lamps used for interior lighting, since these lamps are apt to be trimmed irregularly. In order to make the cutting out of the lamp absolutely positive, independently of the lamp mechanism, Mr. James D. Smith, of Washington, has invented a type of carbon which contains within itself an automatic cut-out, as it were. This is accomplished by incorporating in the carbon a piece of insulating and refractory material, such as burnt fire clay, to interpose itself in the path of the arc and extinguish it. The accompanying engravings show the new carbon, in longi-



tudinal and cross section, A being the carbon proper, and B the refractory insulating material. The position of the cut-out is between the place where the carbon is grasped by the carbon holder and the arc end of the carbon. When the lamp is in operation, the arc consumes the carbon as far as the cut-out, which then interposes itself in the path of the arc and extinguishes it. It will be evident that there is no need to make positive and negative carbons of this kind of certain lengths when trimming, for they will automatically cut out the lamp before the arc reaches the carbon-holders. As a result, also, the carbons can always be entirely consumed, which effects considerable economy.

The Institution of Junior Engineers. — On the 17th inst. a large party of the members of this Institution visited the electric light and dust destruction undertaking of the Shoreditch Vestry, on the invitation of Mr. H. E. Kershaw, Chairman of the Electric Lighting Committee. Under his guidance, assisted by the engineer and the electrician, the visitors were shown over the entire works.

Gas Engines in Mining Plants.—The rapid appreciation of a good thing, which Americans profess to possess, seems to have largely failed them in respect of the gas engine; but at last Americans are waking up, and we note in the *Engineering and Mining Journal* an appreciatory reference to the gas engine as a motive power for mining purposes, which, though late, is very correct. One point specially insisted upon is portability. Now this is a very serious matter with many mines perched in the mountains at points most difficult of access, and where fuel is dear. Only a large steam engine would be economical, and this would demand heavy boilers. With gas power the units of power may be kept small though numerous, and they will still be economical. The gas producer plant can be sent up in sections, and does not require to be made heavy. Again, there may be little or no water available, even were steam power possible. The water, moreover, may be hard, or otherwise bad for boilers. Almost anything will do for a gas engine, and very little is needed to keep the supply up to quantity, for with sufficient cooler tanks evaporative loss can be minimised. The most inferior fuels can be used in gas producers, wood, sage brush or lignite all being available, and, of course, the oil engine, with its various fuels, is to be classed with the gas engine in the eulogium. Our contemporary even refers to the use of gas engines at Seraing, in Belgium, with blast furnace gas, on the principle initiated by Thwaite. There are indeed, apart from blast furnaces, other sources of gas that has hitherto been wasted. The coke ovens, equally with the blast furnace, are huge producers of gas, and when the gases have been made to deposit their tars in the condenser pipes, the effluent gas need only be passed through a scrubber or filter to clear it of grit to make it fit for motive power purposes.

The Blackpool Tower Fire.—It seems to be the fashion with newspaper penny-a-liners to attribute every fire which occurs at premises which are wired electrically to fusion of electric light wires. The public therefore get their heads filled with erroneous notions as to the danger of electric lighting. Much was made by the daily press last week of the Blackpool Tower fire; but while recognising that it was a most serious matter, we cannot overlook the fact that the reports written while the fire was raging were very different from those written after close investigation of the actual facts. The statement that fusion of electric light wires was the cause seems to be incorrect. We understand that the current was turned off at the mains some three-quarters of an hour before the outbreak took place, and a more likely theory is that a smouldering cigar or cigarette end was blown by the wind under one of the fancy goods stalls, of which there are a number at the top of the Tower, and several of which only have been destroyed. The electrical installation is a large and complete one, and has been handed over to the Tower Company by their contractors for about three years, since which time, we understand, it has been thoroughly inspected and kept in repair by the Tower Company's own staff.

Wireless Telegraphy.—Our readers will be interested to note the registration, under our list of New Companies, of the Wireless Telegraph and Signal Company with £100,000 capital, for the purpose of acquiring the Marconi patents.

The German Emperor has ordered comprehensive experiments to be made in wireless telegraphy in Kiel Harbour, before his departure for Russia.

Carbide of Calcium.—The Acetylene Illuminating Company, Limited, of Foyers, announces that, as anticipated in their recently issued pamphlet, "Carbide of Calcium and the Petroleum Acts," it has been prescribed by an Order in Council, held on the 7th inst., that 5 lbs. of carbide of calcium may be kept without a license, *provided* it be kept in separate substantial hermetically closed metal vessels containing not more than 1 lb. each.

The American's Boon, the Englishman's——.—From our New York namesake:—

> What a blessing the telephone is in hot weather! You can sit at your desk, where the electric fan cools you, and transact the larger part of your business without moving or going out into the hot streets. It's great!

This is delightful to Londoners, whose experience of the telephone is that it is not an unmixed blessing, but an unmitigated something else.

Electric Light in the City.—At Tuesday's meeting of the Commissioners of Sewers a report recommending the acquisition of land in Essex for the purpose of getting rid of the City refuse was presented, but a letter was read from the South London Electric Supply Corporation stating their intention of applying next session for a provisional order to supply electric light to the City in competition with the City of London Electric Supply Company. The company suggested the destruction of the City refuse by electricity.

An American Electric Motor Carriage.—Prof. Elihu Thomson is stated to have been at work for two or three years experimenting upon a motor for carriage propulsion. Our New York namesake says that the professor tried various elements, such as gas and gasoline, and various oils, but finally returned to his first love, the electric motor, and while the experiments have been conducted with much secrecy in temporary buildings near the works of the General Electric Company, in Lynn, it is now understood that the perfected electric carriage will shortly be in readiness for public use. The motors are to be placed on the rear axle of the waggon, and a speed of 20 miles an hour can be easily maintained. The electricity will be supplied from a storage battery of greatly reduced weight. The motor is light, and the steering attachment is to be connected with the front wheels. Simplicity and durability are the prevailing characteristics of the mechanism. Mr. Lemp assisted Prof. Thomson in his experiments.

Steam Turbine Tests. — The *Engineer* recently gave the following abstract of a paper by Prof. D. S. Jacobus, of the Stevens Institute, presented at the Hartford meeting of the American Society of Mechanical Engineers, on some "Tests to show the Influence of Moisture in Steam on the Economy of a Steam Turbine":—There has been an impression in the minds of some engineers that the presence of a small amount of moisture in the steam used by a steam turbine might tend to improve the efficiency by increasing the density of the jets of steam that impinge against the buckets of the wheel. Tests were therefore undertaken, in which the amount of moisture in the steam was accurately determined by starting with dry steam and condensing a portion of the same in the steam main leading to the turbine. The heat required to condense the steam, so as to form the moisture, was determined, and from this heat the weight of moisture was calculated. The power developed by the turbine was measured by means of a Prony brake. The total amount of water consumed by the turbine was measured by condensing the exhaust in a surface condenser, and from this total amount the moisture in the steam on entering the turbine was deducted to obtain the weight of dry steam used by the turbine. The conclusions arrived at are:—1. The average dry steam consumption, or the total water consumption, less the weight of entrained water in the steam entering the turbine, was about the same for either dry or wet steam. 2. This may only hold for wheels of a similar type running under similar conditions. The pressure of steam in the tests was about 95 lbs. per square inch above the atmosphere. The turbine wheel was $8\frac{5}{8}$ inches in diameter, and ran at about 10,200 revolutions per minute. At $14\frac{1}{2}$ brake horse-power the dry steam consumption was about $68\frac{1}{2}$ lbs. per hour per horse-power, with either dry steam or steam containing moisture. There were 16 jets of steam impinging on the turbine wheel. These were in groups of four each, and the governor was arranged so that it cut off the steam from one or more of the four groups of jets. Each jet had a width of $\frac{1}{8}$th of an inch, measured in a vertical direction to the plane of rotation of the turbine wheel. The smallest cross-section of each jet was about 0·009 square inch, and the largest 0·15 square inch. The jets issued at an angle of 67° to the radius of the wheel. The turbine wheel was of steel, $8\frac{5}{8}$ inches in diameter, and geared so that the driving shaft ran at one-ninth of the speed of the wheel. The Prony brake was placed on the driving shaft. There were 46 buckets in the turbine wheel. The width of the passages in the wheel, measured at right angles to the plane of rotation, was $\frac{3}{16}$ths of an inch. The area of the cross section of the passages in the wheel was about 0·032 square inch. The angles made by lines tangent to the two sides of a bucket in the wheel, with a radius passing through the bucket, averaged 52° on the inside of the wheel and 69° on the outside.

Electrical Exhibition.—Visitors to Cornwall will have an opportunity of going to a small electrical exhibition and museum in connection with a fête and sale of work at Porthcurnow on August 2nd. Mr. H. G. Cheesman is the honorary secretary.

Liquid Electrodes.—A distinctly novel process has been devised by O. Arlt, of Goerlitz, Germany, for effecting electrolysis by means of liquid electrodes. Of course a special apparatus is required, which consists of a tightly closed vessel with a bottom sloping to an outlet. The electrodes are introduced through perforations in the cover, and are packed to prevent the escape of gas, which is led off through a stand-pipe. The positive electrode consists generally of carbon, and the negative electrode of a jet or spray of mercury, in the case of the electrolysis of brine or any other liquid metal or mixture of one or more liquid metals. The mercury which cannot flow off quickly enough, is protected from the action of the brine by a layer of fluid, such as chloroform or bisulphide of carbon, which is heavier than the electrolyte, and is not acted on by the products of electrolysis, and the sodium amalgam formed is withdrawn from the vessel and treated with steam or water, with the formation of caustic soda and the regeneration of the mercury. Both electrodes may be fluid, and they are introduced into the electrolytes in jets and sprays of any convenient form, their introduction and withdrawal being so regulated that the electrical circuit is never broken.

Signalling through Cables.—In our article on this subject on page 144 of this issue, the commencement of the third paragraph should read: "So for the propagation of electrical disturbances the two insulated conductors of such a cable, though dissimilar in form and size, are exactly," &c. In paragraph 4, for "following series," read "following infinite series."

The Chamberlain and Hookham Meter.—We have received some correspondence from Messrs. Chamberlain and Hookham which has arisen out of the recent judgment, but as the matter is to some extent *sub judice*, we think it would be fairer to hold it over.

The Varley 1866 Dynamo.—We notice in Sir Herbert Maxwell's story of Her Majesty's Reign in "Sixty Years a Queen," published by Harmsworths, a photograph of the first self-exciting dynamo made by Mr. S. A. Varley in 1866.

Gas Engine for Traction Purposes.—Gas engines are steadily coming more to the front in America. One is described in the *Street Railway Review* that is driving the power plant of the Traction Company of Lancaster, Ohio. This company works from three to five cars over four miles of line with some 8 per cent. grades. The chairman of the company, Mr. Kelly, negotiated for the engine with the Western Gas Construction Company of Fort Wayne, and the engine was put in about a year ago. It is known as the American Kilmarnock, being a single cylinder double acting engine, and it develops 130 I.H.P., or 110 B.H.P., its rated size being 100 H.P. The speed is 180 per minute, and it drives an 80 kw. Thomson-Houston 6-pole generator. The following are the leading dimensions:—Cylinder, 16 inches diameter, stroke 20 inches; piston rod, 3 inches; shaft, 7 inches. Two 8 feet fly-wheels with 16 face for belts. Overall length, 15 feet 11 inches; width, 6 feet $10\frac{1}{2}$ inches. The total weight is 34,000 lbs. of which the wheels make up 13,500 lbs. It is to be noted that the bearings are of phosphor bronze without babbit. An American engineer recently remarked that bearings of gun-metal or similar alloy were very little used in America. It is all babbit, and he did not understand how we could put in gun-metal and have no trouble. The trouble must surely be in the alloy. The engine has the porcelain ignition tube, and natural gas under high pressure is used. If there were any natural gas in England we fancy there would not be the lack of gas engines that so curiously characterises American practice. The lead diagram shows great and sudden variations, and load varies from 0 to 180 amperes, and one-sixth of a second only is required for the engine to find its equilibrium. The gas consumed is 16 feet per B.H.P. The same company has built engines of 130 and 90 H.P. for the Marietta Electric Company of similar type but using compressed air for starting purposes.

NEW COMPANIES REGISTERED.

Electric Transformer System, Limited (53,385).—Registered July 19th, with capital of £15,000 in £1 shares (5,000 £5 per cent. cumulative preference(to acquire patent No. 3,379, of 1895, for improvements in distributing electricity, and apparatus therefor, to adopt an agreement with New & Mayne, and to carry on the business of electricians, engineers, &c. The subscribers (with one share each) are: E. Mann, Palace Chambers, Westminster, engineer; H. Bunnett, 9, Hornton Street, Kensington, gentleman; J. Wright, Belmont, Cedars Avenue, Walthamstow, clerk; H. Greatorex, 6, Holtham Road, N.W., clerk; F. L. Wilkinson, 75, South Lambeth Road, S.W., clerk; K. L. Skinner, Brockenhurst, Swanley, secretary; J. Boyce, 23, Spencer's Buildings, Victoria Street, S.W., clerk. The number of directors is not to be less than three, nor more than five. The first are M. D. Rucker, A. G. New, and W. Shrimpton. Remuneration as fixed by the company. Registered by Hind & Robinson, 8, Stone Buildings, Lincoln's Inn, W.C.

Wireless Telegraph and Signal Company, Limited (53,403).—Registered July 20th with capital £100,000 in £1 shares to adopt an agreement with G. Marconi for the acquisition of certain patents and rights relating to telegraphy, and to carry on the business of engineers and telegraphic apparatus manufacturers. The subscribers (with one share each) are:—J. F. Bannatyne, Sumerville, Limerick, gentleman; T. Wiles, 2, Catherine Court, E.C., corn merchant; H. J. Davis, 82, Mark Lane, E.C., engineer; H. Obre, 6, Crosby Square, corn factor; M. T. Goodbody, 6, Crosby Square, E.C., corn factor; C. F. Bennett, 6, Crosby Square, E.C., corn factor; S. W. Ellerby, South Sea House, E.C., corn factor. The number of directors is not to be less than three nor more than seven. The first are E. Appleby, W. Smith, J. F. Bannatyne, H. J. Davis, and G. Marconi. Qualification, £500; remuneration as fixed by the company Registered by Hollams & Co., Mincing Lane, E.C.

Mutoscope and Biograph Syndicate, Limited (53,418).—Registered July 21st with capital £60,000, in £1 shares, to manufacture, sell, and deal in mutoscopes, biographs and mutographs, and other instruments for reproducing and recording speech and other sounds and light by electricity or otherwise. The subscribers (with one share each) are:—J. H. Jack, 19 and 20, Holborn Viaduct, E.C., clerk; E. Foulkes, 19, Kimberley Road, Clapham, clerk; W. E. Stone, 27, Westow Street, Upper Norwood, clerk; C. U. Fisher, 19, Holborn Viaduct, E.C., solicitor; F. W. Daffen, 19 and 20, Holborn Viaduct, E.C., clerk; J. W. Atkinson, 10, Gilbert Street, Bury Street, W.C., clerk; J. Stanley, 21, Holborn Viaduct, E.C., clerk. The number of directors is not to be less than three nor more than seven; the first subscribers are to appoint the first. Qualification £100; remuneration £150 each per annum. Registered by Ashurst & Co., 17, Throgmorton Avenue, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Browett, Lindley & Co., Limited (32,534). — This company's annual return was filed on April 30th. The capital is £20,000, in £10 shares; 1,962 shares have been taken up, and 800 are considered as fully-paid, while the full amount has been called, and £11,620 paid on the others.

Callender's Cable and Construction Company, Limited (48,915).—This company's annual return was filed on July 8th, when the whole capital of £100,000 in £5 shares was taken up, and paid for in full.

CITY NOTES.

National Telephone Company, Limited.

The twentieth ordinary general meeting of the shareholders of this company was held on Thursday at Winchester House, Old Broad Street, under the presidency of Mr. J. S. Forbes.

The Chairman, in moving the adoption of the report, said he trusted they would all be agreed that the report was satisfactory. Of course the proof of the pudding was in the eating, and when under circumstances of considerable difficulty a company of that sort was prosecuted from year to year with a constantly accruing business, and with improving dividends, the task of the chairman was a very easy one. They were getting into a very large income—£476,883 was a big figure for a half year in a business that was progressing as rapidly as theirs. Who knew but what perhaps in the course of the current year the annual income might be very close on a million, and if the advantages of the telephone continued to be understood and as a knowledge of it extended he thought they might look for very large increases in the business in the future. The increase in the income for the half-year amounted to £46,000, but that increase had been almost entirely absorbed by the extra working expenses, which had amounted to £42,000. It must, however, be borne in mind that the accounts for June, 1896, included the trunk line revenue for the first three months of that year, amounting to about £20,000, which money was now received by the Post Office. If they had been in receipt of that revenue the increase would have been £66,000, and the working expenses would not then have been so much out of proportion to the increased revenue. The net result for the half-year, after deducting Post Office royalties, which amounted to £43,156, was a profit balance of £167,010 as compared with £166,523 for the corresponding period of 1896. That royalty to the Post Office was a very good sum for them to receive, but it was an unprecedented burden for a commercial company of that sort, and that fact should be remembered by their critics. After paying the dividends on the preference shares, the directors were enabled to recommend them to divide at the rate of 6 per cent. per annum on the ordinary shares, which was a half per cent. more for the half-year than in the corresponding six months. That was a provisional report, because the company's financial year closed on December. They paid 5 per cent. for the first half of last year, and 6 per cent. for the second half. As he had told them, they proposed to pay 6 per cent. now, and they had the confident hope and belief that at the end they would be able to pay the same amount on the second half, which would give them 6 per cent. for the entire year. After paying the dividends, they proposed to place £35,000 to the reserve fund, and to carry forward £5,665. The marked progress of the undertaking was shown by the fact that the rentals carried forward for unexpired terms of running contracts amounted to £499,962, as compared with £438,321 at the corresponding period of 1896, or an increase of £61,641. Of course, they could not carry on a business of that kind, adding a great number of people from month to month as subscribers, without finding a great deal of money. The peculiarity of the business was that they could not take on a £10 subscriber without spending a great deal more than that amount in anticipation, to provide the machinery for supplying the subscriber, and therefore during the half-year they had spent £193,562 on capital account, chiefly in that direction. They had issued the balance of the 5 per cent. third preference shares, amounting to £653,000, and the average price realised was £5 16s. 6d. Their relations with the Post Office continued to be of the most satisfactory kind. The Post Office and themselves had got a very difficult game to perform—they had got, in fact, to perform the impossible. That was to say, in a business yet somewhat novel, yet not entirely understood, and yet open to constant change of machine, it was expected to go on extending its usefulness, and to satisfy everybody.

Lord Harris, in seconding the motion, said the directors did not mind criticism from the public—in fact, they looked upon such criticism as valuable as keeping them up to the mark. But such criticism was not valuable unless it was based upon a careful comparison of figures and facts. He did not say that the telephone service was perfect—the directors were trying to improve it in every way, but in face of the extraordinary obstructions and opposition that the telephone companies had met with in this country, it was a wonder that we had got any telephone service at all.

After some discussion the report was adopted.

City and South London Railway Company, Limited.

Mr. C. G. Mott presided at the half-yearly meeting of this company held at Winchester House yesterday afternoon. In proposing the adoption of the report, he said the steady progress of the line had been maintained during the half-year. The number of passengers had increased 245,138, and the receipts from passengers £2,382, as compared with the corresponding period of 1896. As regards the extension works, the Moorgate Street station adjoining the Metropolitan line was getting on very well. Shafts were all sunk, and the permanent tunnels had been started. He referred at length to the difficulties encountered in effecting the purchase of St. Mary Woolnoth Church, and said that they were led to suppose that it was a substantial building; but when they came to meddle with it, they found that it was a very poorly built, flimsy structure, and they would have to be extremely careful in upholding it, in order to prevent it coming down about their ears. In consequence, the progress there would at first be somewhat slow. Good progress had been made at the site close to the London Bridge railways at Denman Street. Shafts were down, and the construction of the underground station was being proceeded with. In connection with those extensions they had very carefully to consider the original plans in the light of more recent experience of working; and in order that the very best gradients and the best arrangements for working the line most economically in the future should be carried out, they had had to slightly alter the levels and authorise the construction of certain extra sidings, which would increase the original estimate but not very largely. Arrangements are being made with the Central London Railway Company for the connection by means of a subway of the St. Mary Woolnoth site station and the Central London Mansion House Station. Both companies would bear a portion of the cost of the subway as well as the cost of future maintenance. The chairman as usual went through the various items in the accounts, showing increases and decreases, the sum total of which was that the receipts showed a net increase of £3,348, and the expenses £731, leaving a balance of £2,617. The working expenses of the line came out in the published accounts at 55·67 per cent., but he would give them the percentages with the £1,000 for Jubilee seats deducted, as it was not part of the ordinary working of the railway. The percentage of working expenses this half-year was 57·2, against 60·02 per cent. in the corresponding period last year. If the cost of the lifts was deducted as usual, to compare the line with an ordinary railway, the percentage came out at 50·40 as against 50·71 per cent. for the previous corresponding period. The receipts per train mile had increased from 2s. 2½d. to 2s. 4d., and the receipts per passenger were about the same, 1·90d., against 1·87d. in the previous period. Locomotive expenses per train mile showed a slight increase, and they are now 6·06d., against 5·88d. last year. But there were 2,269 additional trains run, and 7,149 train miles, this half-year. But notwithstanding these facts, the average number of people carried had increased in these trains from 44·59 to 46·54 this year. The figures showed a very satisfactory position. He thought they had every reason to believe that when they got the extensions open they would have a very large traffic and much better dividends than 2 per cent.

Mr. Sampson Hanbury seconded the adoption of the report, and the motion was carried unanimously, as were also other resolutions declaring the dividends on preference and ordinary shares. Votes of thanks closed the meeting.

British Aluminium Company, Limited.

An extraordinary general meeting of this company was held at Westminster Palace Hotel yesterday, to approve of certain minor alterations in the articles of association.

Mr. Roger Wallace, Q.C., who presided, after referring to the objects of the meeting, said the affairs of the company had been going on prosperously since the last meeting. With regard to the legal position of the monopoly, he might say that those who disputed their monopoly had submitted to an injunction with the exception of one or two, who were about to submit. They had obtained an injunction against Messrs. Armstrong, Mitchell & Co., which was the principal firm they proceeded against. In the future, none of the companies who manufactured aluminium abroad would supply aluminium to this country, because they were convinced that the monopoly held in this country was a good one. They were the only company in this country who manufactured aluminium by the electrolytic process, and in connection with this matter there was a company called the Aluminium Supply Company, who had worked up a very good business as agents for the American Company, and to obtain the full benefit of that organisation they had taken a half share in that company. With regard to the other branches of the company, the works at Greenock for the manufacture of carbons for electrical processes had been very much developed, and he expected they would derive considerable benefit from it. At Larne they had other branches of manufacture which promised, in the future, to give additional dividends. They had

developed arrangements in connection with water power in Scotland and Wales, and he thought the shareholders might congratulate themselves upon being first in the field, and being able to secure water powers at very low prices. It was very probable that in the course of this year they would make a separate branch of this company to be devoted solely to the development of the water power. Their engineers had convinced them that they could utilise water power in this country quite as cheap, if not cheaper, than in America and elsewhere. There was the additional advantage that water power in this country was very near the base of utilisation. The manufacture of aluminium was going on better than they expected, and the demand was increasing every day.

The CHAIRMAN then moved the adoption of the resolution making alterations in the articles of association, which was seconded by Dr. ANDREW COMMON.

The Edison & Swan United Electric Light Company, Limited.

THE annual report for the year ending June 30th, 1897, to be presented to the shareholders at Cannon Street Hotel on Friday, July 30th, at 2 o'clock, reads as follows:—The profit and loss account shows a credit balance of £34,850 2s. 2d. Providing for the interest in respect of the debenture stock, there remains a balance of £29,584 13s. 3d. available for distribution. An interim dividend at the rate of 5 per cent. per annum having already been paid in respect of the first half year ending December, 1896, a further payment, at the rate of 6 per cent. per annum, in respect of the second half is recommended, the balance of £8,493 7s. 6d. being carried forward, as against £5,352 14s. 9d. in the preceding year. The amalgamation of the Manchester Edison Swan Company, Limited, as agreed upon and approved by the shareholders at the special meeting on November 24th, 1896, has been completed, and their factory at Broadheath and other effects have been taken over, as well as their interest in the Altrincham Electric Supply, Limited. In accordance with the resolution passed at the meeting of shareholders on November 24th, 1896, due notice was given to the holders of the £100,000 4½ per cent. debenture stock that that stock would be redemed on June 30th, 1897, which has been done. To provide for this and for the extension of business, £200,000 4 per cent. debenture stock has been issued and subscribed at par. The business of the company during the past year has been largely extended, and considerable additions to the shops and plant have been made. James Staats Forbes, Esq., and the Earl of Lichfield retire by rotation from the board, and offer themselves for re-election. Messrs. Welton, Jones & Co., the auditors, offer themselves for re-election. A form of proxy is enclosed for the signature of shareholders who may be unable to attend the meeting, and it is particularly requested that the proxy may be signed and returned to the secretary, Ediswan Buildings, 36 and 37, Queen Street, London, E.C., so that he may receive it not later than Wednesday, the 28th inst. The special direction of any shareholder will be observed.

The Chili Telephone Company, Limited.

THE report of the directors to March 31st, 1897, to be submitted to the shareholders at the annual general meeting, to be held on August 5th, states that the aggregate number of subscribers at all centres at the end of the year was 4,407, as compared with 4,252 at the beginning, or a gain of 155 for the year.

The gross revenue from all sources was:—

In 1896-7	$610,717
In 1895-6	619,826
A decrease of	$9,109

The expenditure in Chili during the year was:—

	$373,009
In the previous year	384,979
A decrease of	$11,970

The net income in Chili from all sources was:—

In 1896-7	$237,707
In 1895-6	234,846
An increase of	$2,861

The average rate of exchange for the year was 17·47d., as compared with 17·27d. in the previous year, giving an increase for the year of 0·20d. Converted into sterling at these rates, the figures given in the preceding paragraph are:—

In 1896-7	£17,300
In 1895-6	16,903
An increase of	£397

The liquid assets and liabilities in Chili on March 31st, 1897, were valued at 17½d., the current rate of exchange on that day, as compared with 17¼d., at which they were valued on the corresponding date of the previous year. The increase in the value of the liquid assets over liabilities in Chili, due to this rise in exchange, amounts to £148, which has been carried to reserve.

The expenditure in London is £76 less than in the previous year.

The balance to the credit of the revenue account, including £557 brought from the previous year, is £12,878, of which £3,351 has been carried to reserve for depreciation and renewals. The directors recommend the payment of a dividend of 4s. per share, less income tax, being at the rate of 4 per cent. per annum, absorbing £8,506, and leaving a balance of £1,020 to be carried forward.

During the year the capital outlay in sterling was £3,316, and the total mileage was:—

	Miles.	Yards.
On March 31st, 1897 ...	7,419	194
„ „ 1896 ...	6,722	269
An increase of ...	696	1,085

In accordance with the articles of association, Mr. George Keith retires from the board of directors, and, being eligible, offers himself for re-election. The auditor, Mr. Thomas A. Welton, also retires, and offers himself for re-election.

Anglo-American Telegraph Company, Limited.

THE directors' report, to be submitted to the shareholders at Winchester House on Friday, July 30th, at 2 o'clock, says that the total receipts from January 1st to June 30th, 1897, including the balance of £369 4s. 8d. brought forward from the last account, amounted to £166,558 9s. 9d. The traffic receipts show an increase of £5,935 as compared with the corresponding period of last year. The total expenses of the half-year, including the repair of cables, &c., as shown by the revenue account, amounted to £53,301 3s. 10d., being a decrease of £3,727 15s. 7d. The directors, under the powers conferred upon them by the articles of association, have, before declaring the net profits, set apart the sum of £12,000 to the renewal fund, leaving a balance of £101,257 5s. 11d. One quarterly interim dividend of 12s. 6d. per cent. on the ordinary stock, and of £1 5s. per cent. on the preferred stock, was paid on May 1st, 1897, absorbing £43,750, and a second quarterly dividend of 14s. per cent. on the ordinary stock, and £1 8s. per cent. on the preferred stock, amounting to £49,000, will be paid on July 31st, 1897, leaving a balance of £8,507 5s. 11d. carried forward to the next account. The company's repairing s.s. *Minia* has been employed during the past half-year in the repair of cables belonging to the Direct United States Cable Company and the Western Union Telegraph Company, the payments for which are included in the revenue account. She is now engaged in the repair of the 1880 cable, broken 170 miles from Newfoundland, and also on the Irish coast. The other cables and landlines of the company are in good working order.

The Globe Telegraph and Trust Company, Limited.

THE twenty-fourth ordinary general meeting of the shareholders of the Globe Telegraph and Trust Company was held on Tuesday last, at Winchester House, Old Broad Street, under the presidency of the Most Hon. the Marquis of Tweeddale.

The CHAIRMAN moved the adoption of the annual report and accounts, and in the course of his remarks, explained that the receipts for the year ended the 18th inst. had amounted to £186,582, being an increase of £1,357. But this increase, although not very great, was important, because it was mainly owing to an improvement which had taken place in the traffic across the Atlantic. This improvement, he believed, was being still maintained, although the full benefit of it would not be felt until the end of the current year. The expenses called for no special remark, except they showed a reduction of about £25 as compared with those of the preceding year. Referring, next, to the change made in presenting the accounts relating to their investments, the chairman stated that shortly after the Trust was formed it was determined, after careful consideration, that any loss resulting from the sale of an investment should be added to the cost of the security purchased with the proceeds. There was a good deal to be said in favour of this mode of rendering the accounts, but it had recently been subjected to considerable criticism, and after due deliberation the directors of the company determined in future to enter the purchase of stocks at their absolute cost price, and to show under a separate heading the profit or loss which was involved in the transactions. He believed the shareholders would approve this change. Undoubtedly, under the old system, the mode of charging the loss on the sale of one security to the price of another was rather complicated, and, to a certain extent, misleading. The figure of £193,778, which appeared as loss on sales of stocks, seemed very large, but it must be remembered that this loss had accrued, not in a year or two, but during the whole continuance of the trust. Moreover, it must be remembered that the depreciation on the stocks of the Anglo-American Telegraph Company had been well known to the shareholders of the Globe Company for a very long time. When the Anglo-American stocks were taken into the Globe their value was somewhat inflated, but the chief reason of the depreciation or the fall in the value of these stocks was owing to the extremely keen competition which sprang up in the Atlantic after the Globe Company was formed. With reference to the sale of certain of their securities, the Chairman said that the sales were confined to the stocks of three companies—the Anglo-American, the Cuba Submarine, and the Commercial Cable. Explaining the reasons which had induced the board to enter on these transactions, he stated that their investments in the Anglo-American Company, which amounted last year to £524,050 of preferred stock and £522,050 of deferred stock, had now been reduced to £367,000 of preferred and £306,000 of deferred stock. It had long been felt that it was not desirable that so large a portion of their capital should be invested in one company, but owing to the low price of Anglo-American stock, and the indisposition of the public to invest in it, it was deemed advisable to wait

until the market improved, which finally occurred owing to the better Atlantic traffics. The proceeds of the sales in question had been applied to increasing their holdings in securities which had already appeared in their list of investments, and in one new security, namely, 300 shares in the Commercial Cable Company, which returned them £4 11s. 5d. per cent. on the purchase price. They also held £28,616 of this company's debenture stock. Their holdings in the West African Telegraph, the Western and Brazilian, and the Western Union Telegraph Companies had been increased. When they compared the present report with that submitted a year ago, he thought the meeting would agree that the company's position was very satisfactory. The present value of their securities, taking the middle market price, represented a sum not less than £4,529,000, which showed a profit over cost of £1,122,500, or, after allowing for the deficiency shown on the balance-sheet through the sale of Anglo-American and other stock, there still remained a surplus balance of over £926,000. He thought it would also be satisfactory to the shareholders to know that their shares had hardly ever reached the figure at which they now stood on the market.

Sir James Pender, Bart., M.P., seconded the motion, which was agreed to, as was also the directors' recommendation as to dividend.

The retiring director and auditors having been re-elected, the usual vote of thanks to the chairman and directors closed the proceedings.

Direct United States Cable Company, Limited.

The ordinary general meeting of this company was held at Winchester House on Tuesday last. Mr. E. M. Underdown, Q.C., who presided, said he thought that on the whole the proprietors would find that the record of the company's proceedings in the last half-year had been satisfactory. Their revenue for the six months ended the 30th ult., after deducting outpayments, amounted in round figures to £43,892, while the working and other expenses, including income-tax, but excluding the cost of cable repairs, had absorbed £19,560, leaving a balance of £24,332 as the net profit of the half-year, making, with the amount brought forward, a total of £29,176. Out of this sum an interim dividend of 2s. 6d. per share was paid for the quarter ended March 31st last, and for the quarter ended the 30th ult. they proposed a final dividend of 2s. 6d. a share, together with a bonus of 2s. per share. They transferred to reserve fund account £4,000, and they would carry forward £3,928. Last December they put £12,000 to the reserve fund, and the amount now added made a total of £16,000 which had been contributed to that fund out of the past year's income. Their revenue showed an increase of £1,436, or about 3½ per cent., over that for the corresponding period of 1896, which period had already shown an increase of about 13 per cent. as compared with that of 1895. With regard to the current year, the traffic kept improving he was glad to say. There had been a reduction in the aggregate in the working expenditure of £132. During the last half-year they had one repair to a cable, and the cost of this had been debited, as usual, to the reserve fund, while £2,000 had been written off the buildings at Ballinskelligs station. On the reserve account they had a credit of £5,447 from interest, and a profit had been made on the realisation of securities of £4,781. These two sums, with the addition of £4,000 from revenue account, brought the balance of the reserve fund up to £338,458 at cost. He should, however, like to say that since December last the investments had been increased by £12,340, and their present market value, on the whole, was about £54,000 more than the figure of cost at which they stood in the accounts. This being so, and in accordance with requests which had been made to them from time to time, they had thought it would be well to give the shareholders a little advantage, while not forgetting the necessity of keeping a good reserve fund. They had therefore concluded to add the bonus mentioned to the dividend, which brought the total distribution for the year up to 3 per cent. It represented a very fair return on the nominal price paid for their shares by the majority of the proprietors. He did not think they would have any falling off in business from the American side. The Tariff Bill was passed, and they knew where they were to a certain extent. There was a large grain crop also. With reference to anything affecting Atlantic telegraphy in general, he thought they might report that any scheme *viâ* the Azores did not acquire any greater probability than it did in former times. They had again a break in their cable a very short distance from the shore, but he hoped they would be able to effect the repair at a comparatively moderate figure, although he would say nothing further about this until the work was done. Although the cable was broken a short distance from the shore, there was not the least interruption to traffic, the landlines and communications carrying all the traffic most satisfactorily. He concluded by moving the adoption of the report and the payment of the dividend and bonus mentioned.

Sir James Pender, M.P., seconded the motion, which was carried unanimously.

Waterloo and City Railway Company, Limited.

The report of the directors for the half-year ended June 30th last, states that the accounts show the expenditure during the past half-year at the sum of £80,079, making a total outlay of £360,605 up to June 30th, 1897. The fourth call upon the share capital of the company, due on February 1st last, was paid up in full. The fifth and final call will probably be required in October next, due notice of which will be forwarded to each of the shareholders. The report of the engineers contains full information as to the state of the works. Every effort is being made to complete the railway, and it is hoped that it may be opened for traffic by the end of the year. Under the agreement of March 8th, 1894, the rolling stock will be provided by the London and South-Western Railway Company, which has ordered the necessary vehicles for the working of the railway. The contracts for the generating station and electrical appliances referred to in the last half-yearly report have been let, and satisfactory progress has been made with these works. The London and South-Western Railway Company's Bill in Parliament, including powers for a street diversion and the acquisition of further property in Lambeth, for the purposes of the Waterloo and City Railway, has passed through both houses, and now only awaits the Royal Assent.

British Thomson-Houston Company, Limited.

The second ordinary general meeting of this company was held on Tuesday, at 83, Cannon Street. Mr. E. A. Lazarus, who presided, referred to the satisfactory nature of the company's business, a considerable increase having taken place in the sales department, especially during the 12 months ended March 31st last. The profits, after deducting general and technical expenses, discounts, and interest, amounted to £22,576. Of this sum, £3,364 had been absorbed in expenses and allowances in connection with the winding up of the old company and the formation of the new one, including liquidator's remuneration and £1,000 paid to the late directors. The board felt, although they did not agree with the management of the old company, that there was nothing which would justify them in treating the directors of it other than in a friendly way, and he hoped the shareholders would agree with what had been done. The £4,255 had been applied in writing off an estimated further loss in respect of the Bristol and Dublin contracts taken over from the old company, and a sum of £4,693 had been written off goodwill, patents, and licenses. These amounts, together with two other small items, accounted for £13,162, leaving an available balance of £9,414, of which it was proposed to transfer £1,128 to the reserve fund, and to pay a dividend of 5 per cent. on the £40,000 "A" shares, fully-paid, on the £40,000 "B" shares, fully-paid, and on the £160,000 "B" shares, £5 paid up, carrying forward to the next account £285. He then moved the adoption of the report, which was seconded by Sir Thomas Thompson, and carried.

The Cambridge Electric Supply Company, Limited.—An extraordinary general meeting of the above named company will be held at the company's offices on Tuesday, August 3rd, at 12.30 p.m., when the following resolutions will be submitted for adoption:—1. That the capital of the company be increased to £100,000 by the creation of 5,000 new ordinary shares of £10 each. 2. That Articles of Association Nos. 13, 14, and 26, be cancelled for purposes of quotation on the Stock Exchange.

Prospectus.—In another part of this issue will be found the prospectus of the St. Lawrence Power Company, of Massena, U.S.A., for which $2,500,000 6 per cent. first mortgage 30-year gold bonds are offered for public subscription. The consulting engineers are Messrs. Kincaid, Waller & Manville. The scheme was described in the Electrical Review a couple of months ago. The list of applications closes to-day.

Venezuela Telephone and Electrical Appliances Company, Limited.—Coupon No. 14 of the 5 per cent. mortgage debentures, due on 31st inst., will be paid from that date at the Capital and Counties Bank, 39, Threadneedle Street, E.C., and at Messrs. Westendorp & Co.'s Bank, Amsterdam.

Stock Exchange Notices.—The Stock Exchange Committee has appointed Thursday, August 5th, a special settling-day in Calcutta Electric Supply Corporation, Limited, 20,000 shares, Nos. 1 to 20,000.

National Electric Free Wiring Company, Limited.—Letters of allotment and regret for the issue of shares were announced as posted early in the week.

The General Electric Company of America, Limited.—A financial contemporary says that a proposal is on foot to reduce the capital of this company, and, as a preliminary to this step, arrangements are being made to settle the question of the accrued dividends on the 7 per cent. cumulative preference stock. There has been no distribution since April, 1893, so that 29¾ per cent. has accumulated. The stock, however, has no preferential rights as to capital.

The County of London and Brush Provincial Electric Lighting Company, Limited.—The warrants in payment of the interim dividend to June 30th, 1897, on the first and second issue of the 6 per cent. preference shares of the company were duly posted on Wednesday.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending July 25th, 1897, were £889; week ending July 26th, 1896, £813; increase, £76; total receipts for half-year, 1897, £3,666; corresponding period, 1896, £3,488; increase, £178.

The Liverpool Overhead Railway Company. The receipts for the week ending July 25th, 1897, amounted to £1,472; corresponding week last year, £1,301; increase, £171.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending July 23rd, 1897, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £2,662.

The Cuba Submarine Telegraph Company. The traffic receipts for the month of April were £3,835, as compared with £6,133 in the corresponding month of last year.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation, July 21st.	Closing Quotation, July 28th.	Business done during week ended July 28th, 1897. Highest.	Lowest
149,900£	African Direct Teleg., Ltd., 4 % Deb.	100	4 %	4 %	...	99 —103	99 —103	101	100½
25,000	Amazon Telegraph, Limited, shares...	10	...	...	...	5 — 6	5 — 6	...	...
923,960£	Anglo-American Teleg., Ltd.	Stock	£2 2s.	£2 9s.	£2 13s.	55 — 58	55 — 58	56	...
3,038,020£	Do. do. 6 % Pref.	Stock	£4 4s.	£4 18s.	£5 6s.	100½—101½	101½ - 102½	102½	101½
3,038,920£	Do. do. Defd.	Stock	...	...	...	10½— 10¾	10¼ - 10⅝	10 11/16	10 5/16
130,000	Brazilian Submarine Teleg., Ltd.	10	7 %	7 %	...	15 — 15½	15 — 15½	15 5/16	15
75,000£	Do. do. 5 %, Debs., 2nd series, 1926	100	5 %	5 %	...	113 —117	113 —117	...	...
44,000	Chili Telep., Ltd., Nos. 1 to 44,000	5	2½%	4 %	4 %	3½— 3⅝	3½— 3⅝	3½	...
10,000,000$	Commercial Cable Co.	$100	7 %	7 %	7 %	170 —175	170 —175	173½	...
653,586£	Do. Do. Sterling 500 year 4% Deb. Stock Red.	Stock	...	...	...	106 —107	106 —107	107½	106¼
224,850	Consolidated Telep. Const. and Main., Ltd.	10/-	1½%	1½%	2 %	7/16— 8/16	7/16— 8/16	...	...
16,000	Cuba Teleg., Ltd.	10	8 %	8 %	8 %	9 — 10	9 — 10	...	...
6,000	Do. 10 % Pref.	10	10 %	10 %	10 %	19 — 20	19 — 20	...	...
12,931	Direct Spanish Teleg., Ltd.	5	4 %	4 %	4 %	3½— 4½	3½— 4½	...	...
6,000	Do. do. 10 % Cum. Pref.	5	10 %	10 %	10 %	9½ - 10½	9½ - 10½	...	...
30,000£	Do. do. 4½ % Debs. Nos. 1 to 6,000 ...	50	4½%	4½%	4½%	103 —106 %	103 —106%	...	...
60,710	Direct United States Cable, Ltd.	20	2 %	2½%	2½%	9⅜ - 10½	9⅜ - 10½	10	9 15/16
400,000	Eastern Teleg., Ltd., Nos. 1 to 400,000	10	6½%	6½%	6½%	17 — 17½	17 — 17½	17 5/16	16 7/8
70,000	Do. 6 % Cum. Pref.	10	6 %	6	6%	18 — 19	18 — 19	18 1/16	18⅜
89,900£	Do. 5 % Debs., repay. August, 1899	100	5 %	5 %	5%	103 —106	103 —106	...	...
1,302,615£	Do. 4 % Mort. Deb. Stock Red.	Stock	4 %	4 %	4%	128 —131	128 —131	129½	128
250,000	Eastern Extension, Australasia and China Teleg., Ltd. ...	10	7 %	7 %	7½	17⅞— 18¼xd	17⅞— 18¼	18	17⅞
35,500£	Do. 5 % (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	5 %	5 %	5%	99 —103	99 —103	...	...
133,100£	Do. do. Bearer, 1,050—3,975 and 4,327—6,400	100	5 %	5 %	5%	100 —103	100 —103	...	...
320,000£	Do. 4 % Deb. Stock	Stock	4 %	4 %	4%	130 —133	130 —133	130¼	...
51,100£	Eastern and South African Teleg., Ltd., 5 % Mort. Deb. 1900 redeem. ann. drgs., Reg. Nos. 1 to 2,343	100	5 %	5 %	5%	99 —103	99 —103	...	...
69,200£	Do. do. do. to bearer, 2,344 to 5,500	100	5 %	5 %	5%	100 —103	100 —103	...	...
300,000£	Do. 4 % Mort. Debs. Nos. 1 to 3,000, red. 1909	100	4 %	4 %	4%	105 —108	105 —108	...	...
200,000£	Do. 4 % Reg. Mt. Debs. (Mauritius Sub.) 1 to 8,000	25	4 %	4 %	4%	107 —110 %	107 —110%	...	...
180,227	Globe Telegraph and Trust, Ltd.	10	4½%	4½%	4½%	11½— 12	11½— 12	12	11⅜
180,042	Do. do. 6 % Pref.	10	6 %	6 %	6%	17 — 17½	17 — 17½	17⅜	17 1/16
150,000	Great Northern Teleg. Company of Copenhagen	10	8⅜%	10 %	10%	26 — 27	26 — 27	26½	...
160,000£	Do. do. do. 5 % Debs.	100	5 %	5 %	5%	104 —107	104 —107	...	...
17,000	Indo-European Teleg., Ltd.	25	10 %	10 %	10%	54 — 57	54 — 57	55	...
100,000£	London Platino-Brazilian Teleg., Ltd. 6 % Debs. ...	100	6 %	6 %	6%	107 —110	107 —110	...	...
28,000	Montevideo Telephone 6% Pref., Nos. 1 to 28,000... ...	5	4 %	4 %	...	2 — 2¼	2 — 2¼	...	...
484,597	National Teleph., Ltd., 1 to 484,597	5	5 %	5¼%	5¼%	6⅞— 7⅛	6⅞— 7⅛	7⅛	6⅞
15,000	Do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	16	15 15/16
15,000	Do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	15 — 17	15 — 17	...	...
119,234	Do. 5 % Non-cum. 3rd Pref., 1 to 119,234	5	5 %	5 %	5 %	6 — 6¼	6 — 6¼	6⅜	6½
1,329,471£	Do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	105 —110	105 —110	108	106½
171,504	Oriental Teleph. & Elec., Ltd., Nos. 1 to 171,504, fully paid	1	4½%	5 %	5 %	⅝— ¾	⅝— ¾	...	...
100,000£	Pacific and European Tel., Ltd., 4 % Guar. Debs, 1 to 1,000	100	4 %	4 %	4 %	107 —110	107 —110	...	...
11,839	Reuter's Ltd.	8	nil	5 %	5 %	7 — 8	7 — 8	...	...
3,381	Submarine Cables Trust	Cert.	...	...	...	135 —140	135 —140	...	...
58,000	United River Plate Teleph., Ltd.	5	3 %	4 %	...	3½— 4 xd	3½— 4	...	...
146,733£	Do. do. 5 % Debs.	Stock	5 %	5 %	...	99 —104	100 —105	...	...
15,609	West African Teleg., Ltd., 7,501 to 23,109	10	nil	4 %	nil	5 — 6	5 — 6	...	...
213,400£	Do. do. do. 5 % Debs.	100	5 %	5 %	5 %	102 —105	102 —105	...	...
64,256	Western and Brazilian Teleg., Ltd.	10	3 %	3 %	2 %	9 — 9½	9 — 9½	9½	9¼
33,129	Do. do. do. 5 % Pref. Ord. ...	7½	5 %	5 %	5 %	6¾— 7½	6¾— 7½	7	...
33,129	Do. do. do. Def. Ord.	7½	1 %	1 %	...	2¼— 2¾	2¼— 2¾	2 7/16	...
382,230	Do. do. do. 4 % Deb. Stock Red. ...	Stock	...	...	...	100 —103	101 —104	102¼	102
88,321	West India and Panama Teleg., Ltd.	10	¼%	¼%	1 %	¾— 1½	¾— 1½	1	...
34,563	Do. do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	10¼— 10⅝	10¼— 10⅝	10¼	...
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	9 — 10	9 — 10	...	...
80,000£	Do. do. 5 % Debs. No. 1 to 1,800 ...	100	5 %	5 %	5 %	105 —108	105 —108	...	...
1,163,000$	Western Union of U. S. Teleg., 7 % 1st Mort. Bonds ...	$1000	7 %	7 %	7%	104 —108	104 —108	...	...
160,100£	Do. do. 6 % Ster. Bonds.	100	6 %	6 %	6%	100 —105	100 —105	...	...

ELECTRICITY SUPPLY COMPANIES.

30,000	Charing Cross and Strand Electy. Supply	5	4½%	5 %	6 %	13 — 14	12½ - 13½	13	...
20,000	Do. do. do. do. 4½ % Cum. Pref.	5	...	...	...	6 — 6½	6 — 6½	6 15/16	6 5/16
26,000	*Chelsea Electricity Supply, Ltd., Ord., Nos. 1 to 10,277 ...	5	5 %	5 %	5 %	9⅜ - 10½	9⅜— 10½	9⅜	...
60,000	Do. do. do. 4½ % Deb. Stock Red. ...	Stock	...	4½%	4½%	110 —113	110 —113	...	...
40,000	City of London Elec. Lightg. Co., Ltd., Ord. 40,001—80,000	10	5 %	5 %	7 %	23½ - 24½	23½ - 24½	23⅞	23 9/16
40,000	Do. do. 6 % Cum. Pref., 1 to 40,000	10	6 %	6 %	6 %	16½ - 17½xd	16½ - 17½	16⅝	16⅜
400,000	Do. 5 % Deb. Stock, Scrip. (iss. at £115) all paid	...	5 %	5 %	5 %	129 —134	129 —134	...	...
22,475	Jounty of Lond. & Brush Prov. E. Ltg. Ltd., Ord. 1—22,475	10	...	nil	nil	12⅜— 13½	12⅜— 13½	13	12⅞
10,000	Do. do. do. 6% Pref., 40,001—50,000 ...	10	...	6 %	6 %	15 — 15½xd	15 — 15½	15⅜	15¼
10,000	Do. do. do. iss. at 2 pm., all paid	10	...	...	...	15 — 15½xd	15 -- 15½	...	...
10,000	House-to-House Elec. Light Supply, Ord., 101 to 10,100	5	...	...	...	8½— 9	8½— 9	...	...
49,900	*Metropolitan Electric Supply, Ltd., 101 to 50,000 ...	10	3 %	4 %	5 %	16½ - 17½	16½— 17⅛	17	16¾
12,500	Do. Ord., 50,001—62,500, iss. at £2 prem. ...	10	...	...	...	15 — 16 xd	15 — 16	16 3/16	...
220,000	Do. 4½% first mortgage debenture stock	...	4½%	4½%	4½%	118 —122	118 —122	...	...
6,452	Notting Hill Electric Lightg. Co., Ltd.	10	1 %	2 %	4 %	15 — 16	15 — 16	...	...
19,980	*St. James's & Pall Mall Elec. Light Co., Ltd., Ord., 101-20,080	5	6½%	7½%	10½%	15½— 16½	16½— 17½	17⅛	16¾
20,000	Do. do. 7 % Pref., 20,081 to 40,080	5	7 %	7 %	7 %	10 — 11	10 — 11	...	...
50,000	Do. do. 4 % Deb. stock Red. ...	Stock	...	...	...	102 —105	102 —105	...	...
67,900	*Westminster Electric Supply Corp., Ord., 101 to 68,000 ...	5	5 %	7 %	9 %	15 — 16	15 — 16	15½	15 7/16

* Subject to Founder's Shares. † Quotations on Liverpool Stock Exchange.

‡ Unless otherwise stated all shares are fully paid. ‖ Dividends paid in deferred share warrants, profits being used as capital.

¶ Dividends marked ¶ are for a year consisting of the latter part of one year and the first part of the next.

SHARE LIST OF ELECTRICAL COMPANIES - *Continued*

ELECTRICAL RAILWAY, MANUFACTURING, AND INDUSTRIAL, COMPANIES.

Present Issue.	NAME.	Stock or Share. †	Dividends for the last three years. 1894.	1895.	1896.	Closing Quotation July 21st.	Closing Quotation, July 28th.	Business done during week ended July 28th, 1897. Highest.	Lowest.
20,000	British Electric Traction	10	...	...	...	12½ — 12⅝	13 — 13⅛	13⅛	12⅝
90,000	Brush Elect. Enging. Co., Ord., 1 to 90,000...	8	2½%	...	...	1⅝ — 1⅝	1⅝ — 1⅝	...	...
90,000	Do. do. Non-cum. 6 % Pref., 1 to 90,000	2	3 %	...	...	1⅝ — 1⅝	1⅝ — 1⅝	1½	...
125,000/	Do. do. 4½ % Perp. Deb. Stock.... ...	Stock	4½%	...	...	105 —109	105 —109	...	...
76,770	Do. do. 4½% 2nd Deb. Stock Red. ...	Stock	...	...	...	93 — 97	93 — 97	93	...
19,126	Central London Railway, Ord. Shares	10	...	...	...	9⅝ — 10¼	9⅝ — 10¼	10 1/16	...
143,106	Do. do. do. £6 paid	10	...	...	...	5⅝ — 6¼	5⅝ — 6¼	5⅝	...
58,830	Do. do. Pref. half-shares £1 pd. ...	...	...	...	...	1½ — 1⅝	1½ — 1⅝	...	...
61,777	Do. do. Def. do. £5 pd. ...	...	...	...	...	4¼ — 4⅝	4¼ — 4⅝	...	...
630,000/	City and South London Railway	Stock	1½%	1 8/16%	1 8/16%	62 — 64	63 — 65	64⅝	64½
28,180	Crompton & Co., Ltd., 7 % Cum. Pref. Shares, 1 to 28,180	5	*nil*	*nil*	...	1½ — 1⅝	1½ — 2	...	...
89,261	Edison & Swan United Elec. Lgt., Ltd., "A" shrs, £3 pd. 1 to 89,261	5	5 %	5 %	...	2¼ — 2⅜	2¼ — 2⅜	2¼	...
17,139	Do. do. do. "A" Shares 01—017,139	5	5 %	5 %	...	3½ — 4½	4½ — 4⅝	4⅝	..
110,000	Electric Construction, Ltd., 1 to 110,000	2	*nil*	5 %	5½%	1⅝ — 2	1⅝ — 2	2	1⅞
16,343	Do. do. 7 % Cum. Pref., 1 to 12,845 ...	2	7 %	7 %	7 %	2⅝ — 3¼	2⅝ — 3¼	3 3/16	...
91,195	Elmore's Patent Cop. Deposg., Ltd., 1 to 70,000	2	*nil*	...	...	⅜ — 1	⅜ — 1	...	...
67,275	Elmore's Wire Mfg., Ltd., 1 to 69,385, issued at 1 pm. ...	2	*nil*	...	...	⅛ — ⅜	⅛ — ¾	...	...
9,600/	Greenwood & Batley, Ltd., 7 % Cum. Pref., 1 to 9,600 ...	10	*nil*	10½%	..	9 — 11	9 — 11	...	...
12,500	Henley's (W. T.) Telegraph Works, Ltd., Ord.	10	6 %	8 %	10 %	18½ — 19½	18½ — 19½	19¼	...
3,000	Do. do. do. 7% Pref.	10	7 %	7 %	7 %	18½ — 19½	18½ — 19½	...	...
50,000	Do. do. do. 4½ Mort. Deb. Stock	Stock	...	4½%	4½%	108 —113	108 —113	...	...
50,000	India-Rubber, Gutta Percha and Teleg. Works, Ltd. ...	10	10 %	10 %	10 %	20½ — 21½xd	20½ — 21½	21½	20½
300,000	Do. do. do. 4 % 1st Mort. Debs.	100	...	...	...	105 —108	105 —108	106	...
37,500	†Liverpool Overhead Railway, Ord.	10	1½%	2⅞%	2⅞%	12⅜ — 12½	12¼ — 12⅜	...	...
10,000	† Do. do. Pref., £10 paid	10	5 %	5 %	5 %	15½ — 16	15½ — 16	...	...
37,350	Telegraph Constn. and Maintce., Ltd.	12	20 %	15 %	15 %	36 — 39	36 — 39	38½	...
150,000	Do. do. do. 5 % Bonds, red. 1899	100	5 %	5 %	5 %	102 —105 xd	102 —105	...	...
54,000/	Waterloo and City Railway, Nos. 1 to 54,000, £8 paid ...	10	...	...	...	10⅞ — 11¼	10⅞ — 11¼	10⅞	...

Quotations on Liverpool Stock Exchange. † Unless otherwise stated all shares are fully paid. ¶ Last dividend paid was 50% for 1890.
Dividends marked § are for a year consisting of the latter part of one year and the first part of the next.
CROMPTON & Co.—The dividends paid on the ordinary shares (which have not a Stock Exchange quotation), are as follows: 1892—0%; 1891—7%; 1890—8%

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Birmingham Electric Supply Company, Ordinary of £5 (£4 paid), 7⅞, £5 (fully paid) 9⅛.

Electric Construction Corporation, 6 % Debentures, 103—106.

House-to-House Company, 7 % Preference, of £5, 10¼—10⅜xd.

Do. do. 4½% Debentures of £100, 109—111.

Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid) 13—13½; 1st Preference Cumulative 6 %, £5 (fully paid), 8—8½. Dividend, 1896, on Ordinary Shares 7 %.

London Electric Supply Corporation, £5 Ordinary, 1⅜—2.

Yorkshire House-to-House Electricity Company, £5 Ordinary Shares fully paid, 9¼—9⅜. Dividend for 1896—6 %.

* From Birmingham Share List.

Bank rate of discount, 2 per cent. (May 13th, 1897).

THE MUNICIPAL ELECTRICAL ASSOCIATION, 1897.

(*Concluded from page* 135.)

THE LOCALISATION OF FAULTS IN UNDERGROUND MAINS.

By ROBT. C. QUIN, A.I.E.E., Borough Electrical and Tramway Engineer, Blackpool.

THE mileage of cable laid under streets has increased rapidly within the last few years, and more especially does this increase show itself in the area and complexity of distribution networks. Whether the cause be electrolytic, chemical (internal or external), electrostatic, or mechanical, with the ageing of the cables come the troubles of the station engineer's life—cables faults; and the increasing complexity of the network renders more difficult the task of their localisation.

It has been the lot of the writer (fortunately or otherwise) to have had more than his fair share of cable trouble, and if the results of his experience help to lighten the burden of brother engineers, the recompense will be ample.

Many methods of localisation have been suggested, the readiest undoubtedly being the antiquated "cut and try." Of the remainder, the majority consist of some modification of the loop test; but by all methods previously suggested, with the exception of the "telephone and induction coil" and compass methods, the resistance of the cable is measured directly or indirectly. When we consider the very low resistance of the average distributing main per yard, it is easy to see the impossibility of accurately locating the fault by any method which takes resistance into account.

Furthermore, accurate methods of testing are not possible in a crowded thoroughfare, and standing at a street corner in a blizzard is not the most delightful situation in which to solve an abstruse mathematical calculation.

When a fault appears on the network, the first step necessary for its removal is, obviously, to locate the section or district in which it exists; and for this purpose the "Berlin" system of automatic signalling is one which recommends itself. But the cost of installation, especially where the network is already laid, practically prohibits it. A somewhat similar system, however, is within easy reach of all.

Property in "earth" does not exist, but it behoves electric lighting authorities not to interfere with the due and proper working of telephone companies' apparatus. Many hard words have been said as to the National Telephone Company's use of earth returns, but it will be a bad day for the "trouble" man when these "earths" give place to metallic returns.

If the "Berlin" system cannot be afforded, arrangements might be made with the local telephone exchange to allow connection to be made (say at 7 a.m., or some other time when the telephones are not generally in use) from the mains, through a suitable resistance to their exchange "earth." It is quite as efficacious, and not nearly so expensive. It protects the telephone company from undue interference, by enabling the sections in which faults exist to be located before the faults become serious. It requires only a comparatively small current to drop the indicators when connection is made direct to the exchange "earth," but a very much larger current is required when the central is not (if the term may be used) one of the "spheres of influence." Once the numbers of the fallen indicators have been ascertained, it is not a difficult matter to plot the positions of the telephones on the map, and thus find the whereabouts of the second "sphere of influence." It is possible there may be more than one faulty section, but the numbers of the telephones will soon show this.

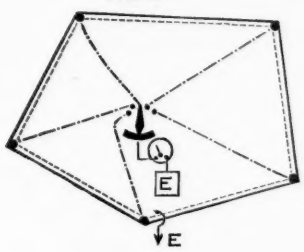
Where direct feeders are used, and voltage pilot wires are laid down, these latter can be employed for localising faults; but as their number is generally far short of that of the telephones, this method can take only a secondary place. The method of using the pilot wires which the author would suggest is as follows:—

Assuming the fault to be on the negative, earth the negative bus bar at the works, and take the potential between the negative pole at any feeding point, by means of the negative pilot wires, and "earth" at the works. The feeding point having the least D.P. to earth, is the one nearest to the fault. A high resistance voltmeter should be used, otherwise the resistance of the pilot wire has an appreciable effect. Should the fault be on the + pole, then that pole must be earthed.

Another method, which consists of the insertion of small fuses in the feeders, has given very good results; but it necessitates the use of a comparatively large current to earth, and also is applicable only

where direct feeders are used. The *modus operandi* is as follows:—Fuses are inserted at the time of light load between the bus bar and the feeders on the pole on which the fault exists, of such a capacity that if two or three blow, the remainder will safely carry the load. The insulated pole is temporarily connected to earth at the works, and the order in which the first two or three fuses melt is noted. The diagram (2) shows generally the scheme and the order in which the

Fig. 1.



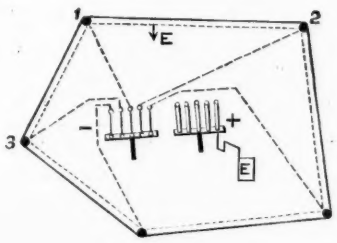


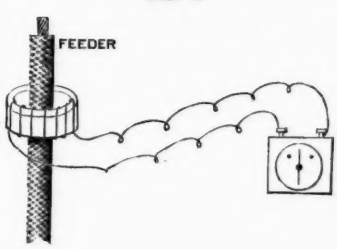
Fig. 2.

fuses would blow. Should any doubt exist as to the correctness of the order, it is as well to repeat the test; but the writer has not at any time found this necessary.

One other method, applicable only to continuous current systems, deserves mentioning. It is, the writer believes, in use at Liverpool. Around each feeder is placed a small annealed iron ring wound as shown in fig. 3, the network being divided in such way that a portion is fed separately by each feeder.

It is quite clear that a steady current will have no effect upon the indicator, and therefore, in testing for faults, the insulated pole is intermittently connected to earth, and the throw of the needle on each feeder ascertained. It is said that with a leak as small as one ampere, the throw is quite perceptible.

Fig. 3.



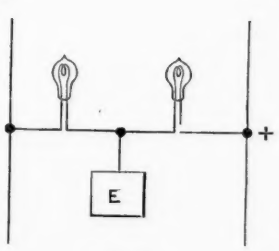


Fig. 4.

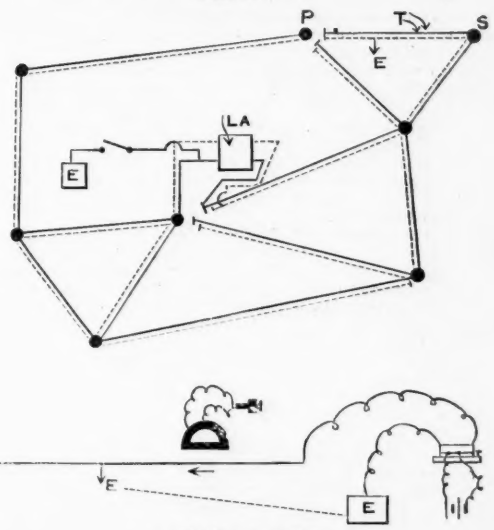
A passing word may not be out of place as to the lamp signal method (fig. 4) generally in use for notifying the presence of a fault on the mains.

Such a method is good when it has been adopted from the commencement, and care has been taken to remove immediately every fault which has developed. But even then there is considerable risk of faults developing slowly and simultaneously on both poles. Under these circumstances the apparatus is not reliable. What does it tell us? Simply that the potential difference to earth is equal on both sides of the mains, which, as far as insulation resistance is concerned, means nothing. There might even be a short circuit, but so long as the resistance to earth is the same on both poles, the lamps will be equally bright, or dull.

Some time back the author designed an instrument, really a differential ammeter, for the purpose of finding the sections in which these small leaks were, and he was very much surprised at the number found, and of which no evidence existed at the works.

Fig. 5 is a diagram of its method of use. As will be seen, it is inserted in the network, and forms the feeder from the main network to the section or district to which the fault has been localised by any of the methods previously described. It is essential that the whole of the current required for the isolated network should pass through the instrument. When the connections to the ammeter are completed, the faulty district should be separated, but not before. The

Fig. 5.



L A, Leakage ammeter.

Fig. 6.

main network is then temporarily earthed, and the deflection of the instrument needle noted. Should the leak be in the isolated district, the instrument will read the leakage current in amperes, but is not there, there will be no deflection, the reason being that all circuits, other than earth, are completed through the instrument, and therefore their algebraic sum is nil.

Assuming that the fault has shown itself to be in the isolated network, connect the branch, T, fig. 5, to the main network at P, and then disconnect at S. Again earth the main network at E, no deflection will be obtained, showing that with removal of branch, T, the fault has been transferred to the main network, and that therefore the fault is in branch T. It will be seen that continuity of supply has been maintained throughout the whole time of test.

The instrument is one made to the writer's instructions by Mr. G. Alderton, of 45, Clifton Street, Brighton. and is now in use by the Brighton Corporation. It is a three-wire one, and has a carrying capacity in each conductor of 300 amperes, and a range of reading from 3 amperes to 100 amperes. Of course the range and carrying capacity can be varied to suit any requirements. It is applicable to alternating as well as continuous current networks.

Several methods of arriving at the location of a faulty branch in a network has been shown, and the author must leave his readers to select the one which appears to suit the special local conditions to which they wish to apply it. Personally, he has a predilection in favour of the telephone signal system, following this up with the leakage ammeter.

Dealing now with faults on alternating high tension feeders. An electrostatic voltmeter certainly appears to be the best and most serviceable fault indicator. To locate the feeder having the fault is not a difficult matter where entirely separate feeders on separate alternators are used. When alternators are paralleled on to a common bus bar, it is as well to parallel an additional machine on to the bus, then to connect this alternator by jack cords to the hospital terminals of any one circuit (most switchboards allow of this or similar connections being readily made), and finally, by disconnecting the extra machine from the bus bar, leave it supplying only the particular feeder required. The electrostatic voltmeter can then be applied, and if necessary the extra machine paralleled back again to the bus, and then withdrawn on another circuit.

These complications apply only to systems in which separate feeders are used to supply independent networks, and when the engineer considers, as the author does, that continuity of supply is an important factor in the problem of commercial electric lighting.

Where the feeders supply into a common network, they can, of course, be disconnected individually without stoppage of supply and tested by the ordinary methods.

The tendency, however, at present, is towards the use of concentric or twin cables for high tension feeders, and with either of these a fault means a short circuit, and this is very promptly indicated by the fuses.

We now come to the crux of the whole problem. Given a length of main in which a fault (say, an "earth") exists, by what method and in what manner shall we be able to accurately locate its position?

The loop test offers a fairly good solution when the resistance of the conductor is high, but when dealing with low resistance con-

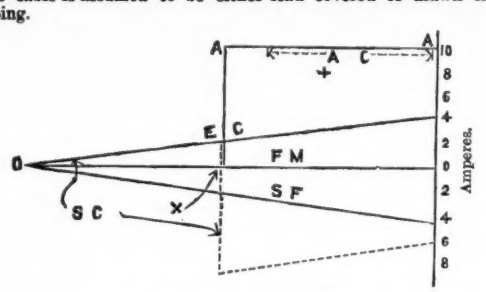
ductors (say, with 50 yards of ·3 distributor having a resistance of ·00008 ohms per yard), it is well nigh impossible to accurately test its position—especially when we consider that the conditions under which the test must be made are not conducive to superfine methods. So often has the loop test failed in practice, that the author has been forced to abandon it, and seek a test more reliable.

But before dealing with the method which the writer now adopts and recommends, mention will be made of one or two others which he has tried with varying success.

The first of these non-resistance methods is the "telephone and induction coil," shown in fig. 6, when the supply is alternating the "induction coil" can be dispensed with and a connection made to the mains.

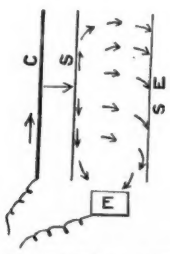
This appears beautifully simple and reliable on paper, but unfortunately it has serious drawbacks. Theory, at least laboratory theory, says "from induction coil to fault, hum; beyond, silence." You travel along the line of main, carefully tracking the cable with the search coil, and listening intently at the telephone receiver; presently silence—the fault! no, only the telephone diaphragm jammed. You travel still further, and further, until you arrive at the end of faulty branch; but still that maddening hum continues with scarcely diminished vigour. This method *might* have been a good one before the days of metal sheathed conductors, of conductors drawn in iron piping, of gas and water mains, and sundry other things; but these things do exist now, and consequently the method must take a back place.

A little consideration will show us the reason of the continual hum, and consequent failure to locate the fault. Fig. 7 is a diagram of the currents and circuits obtained by this method—the applied current, A A, being taken at 10 amperes, 0 0 is the faulty main, x the fault. The cable is assumed to be either lead covered or drawn in iron piping.



A C, Applied current; E C, Effective current; F M, Faulty main; S F, Stray field S C, Sheathing current.

Fig. 7.



C, Conductor; S, Sheathing; S E, Stray earth.

Fig. 8.

It is contrary to common sense and Ohm's law to expect that the applied current, when the point, x, is reached, would complete the circuit either entirely by the sheathing or entirely by stray earth, *i.e.*, by gas and water mains out of the search coil field. If the former were the case, we should get a concentric main free from external induction, and quite useless for our purpose; with the latter the whole of the applied current would be effective. But as has been previously said, both of these conditions are impossible, the probable distribution being more in accordance with fig. 8.

If the earth lead were connected to the gas or water mains, the whole of the current would have to pass from the sheathing to the gas or water mains, but it would first be distributed along the sheathing. A reference to figs. 7 and 8 will show that the sheathing current on the home side is opposing the effect of the current in the conductor, and rendering the test less sensitive, and further that the sheathing current on the far side continues the effect of the conductor current.

If at the point x, fig. 7, the current in the sheathing on the home side be 8 amperes, then the effective is 10 − 8 = 2 amperes, 10 amperes being the applied current in the conductor. The sheathing current on the far side also becomes 2 − 0 = 2 amperes, gradually diminishing to zero as the circuit is completed, *viâ* gas and water mains. The effective current is, therefore, directly proportional to the difference between the conductor and sheathing currents, or in other words, to the strength of the stray field. But while this method relies for its sensitiveness and accuracy on the strength of the stray field, the fact of the existence of such a field necessitates the distribution of the sheathing current, and is therefore the reason of its failure.

The symmetry of fig. 7 will not, of course, be preserved in practice, the crossing of gas and water services and mains will give rise to steps in current value, and also in volume of humming sound, but these steps are quite as likely to occur at a perfect point in the main under test as at the fault.

One or two cases from the author's experience will help to substantiate this explanation. Having arrived at the section of a network in which a fault existed, he instructed an assistant to locate the position of the fault, giving him for this purpose a specially made search coil and telephone receiver. The author found the tester shortly afterwards tracking a gas main down a side street in which no cables were then laid, a strong proof of the extent of the stray field. This search coil was flat at the bottom, and about 4 feet long, the sides were 6 feet high, and vertical, the top being semi-circular; in fact, it resembled nothing more than a semi-circular headed window frame. The current used was intermittent, the cables being single lead-covered and armoured.

The next case occurred when locating a fault on rubber cables which were drawn in iron piping. In this instance the current was alternating, and the search coil of smaller dimensions. Having located the fault (by what method really does not matter, except to say that in this case no testing instruments were required), and while the current was still on, the author took the opportunity of tracking the cable beyond the fault and found a very definite hum quite 200 yards away when the coil was placed on the ground above the pipe containing the cable. He then had a draw-box opened and placed the search coil in the box and on the faulty cable, but no hum was then obtained, thus showing that the effect was due entirely to the sheathing current.

The next method to be touched upon is one which entails the use of an intermittent current. The compass test shown in fig. 9 is referred to. No comment is needed beyond saying that the writer has found, as would be expected, that it had all the faults of the telephone method previously described.

But this compass method, unreliable though it is in its crude form, is capable, with slight modifications, of some surprisingly accurate results. Fig. 9 gives the connections for this modified method.

Fig. 9.

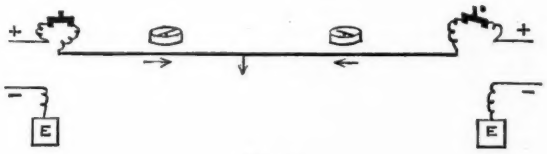


Fig. 10.

It will be seen that it is neither more nor less than the original compass method applied simultaneously to both ends of the faulty main.

There are certain precautions, however, to be taken when using this, viz., all other cables in the same trench must be disconnected, otherwise their influence will render the test unreliable, the compass needle must be brought parallel to the main (for this purpose a bunch of keys forms a handy controlling magnet, the keys of the electrical engineer being usually magnetised), the current must be applied simultaneously at both ends and the direction of the steady deflection noted. Where one pole of a network, other than the faulty main, is already earthed, it is advisable to connect that pole to earth at each end of the main under test; otherwise connect the negative or outer with two-wire system, or neutral or outer with three-wire system, to earth.

A glance at fig. 11 will show the probable circuits and currents obtained when this method is used, the same ratios of current values being taken here as in fig. 7. It will be observed that at the fault the effective current is nil, that it reverses its direction on either side of the fault. The *modus operandi*, therefore, is to place the compass on the ground over the cable, adjust the compass so that the needle is parallel to main, switch on current at both ends, then if the needle is permanently deflected to the right or left as the case may be, you are still on the home side of the fault; switch off current and move farther along cable, and proceed as before. Should the direction of deflection reverse, you have passed the fault.

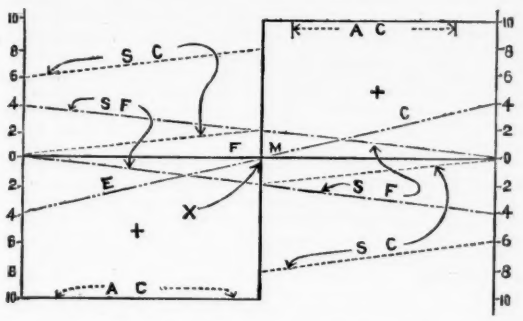
The author has used this method very largely, and has invariably been successful in locating the position to within a yard either way.

But this method has nevertheless several disadvantages. In the first place it is only applicable to continuous current networks, and secondly, it requires a considerable current to earth, the minimum being about 30 amperes, with metal-sheathed conductors laid about 2 feet 6 inches below the surface. In this connection the author may say, having dealt with considerably more than a hundred, that faults in lead-covered cables are generally of the order of an ohm, and therefore, under ordinary circumstances, the requisite current is easily obtainable.

We now come to the author's final method, and the reasons which led him to adopt it may not be without interest. The conditions which a perfect test should satisfy, and which he laid down when devising his were—1, resistance must not be a factor; 2, a small cur-

rent only must be required; 3, it should be of practically universal application.

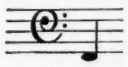
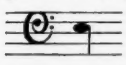
Now the principle underlying fig. 11 seems to the author to be as near the ideal as we are likely to attain; but the great problem which besets us is how to apply this to alternating current mains; how to obtain the necessary reversal, alteration, or modification at the fault? There is only one characteristic which can be effectively varied, viz., periodicity, and upon this principle he has based the method which he now recommends.



A C, Applied current; E C, Effective current; F M, Faulty main; S F, Stray field; S C, Sheathing current.

Fig. 11.

Fig. 12 shows the general connections, and it will be seen that at each end of the main is placed an induction coil, the contact breakers being of different lengths, one pole of each coil being connected to the faulty main, the other being connected to a gas or water-main earth for preference. Where the general supply is alternating, this can be applied through a resistance to one end of the main in question, using an induction coil or small motor alternator at the other end.

As regards the difference of periodicity, the author prefers to use 84 periods and 160 periods per second, (giving approximately  and ); the memory of one tone and the impression of the other produce a wholesome discord, which is very effective in bringing the tracker to a halt, especially when he has what is generally termed a "musical ear."

As regards the sensitiveness of the test, this of course depends largely upon the design of the apparatus. The search coil and telephone receiver which the author is now using is one of special construction designed by himself, and constructed by his mains engineer. The receiver, which is placed in the centre of the search coil, consists of an ebonite drum containing a cylindrical laminated steel

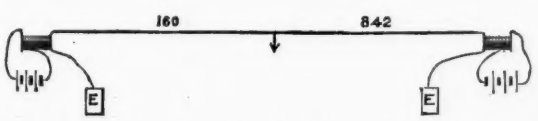


Fig. 12.

magnet forming the core of a finely wound bobbin, connected in series with the search coil. At each end of the magnet is fixed a diaphragm and resonator chamber, connected to which latter are phonograph ear tubes. The whole is contained in a box 12 inches × 9 inches × 7 inches, and weighs about 7 lbs. It has proved to be very sensitive, 1 ampere effective current giving a distinctly audible hum at a distance of 10 feet.

It requires but little ingenuity to adapt this method to any possible earth. There is, however, one class of fault, fortunately of rare occurrence, which needs mentioning. With pilot cables, whether of multiple type or otherwise, it sometimes happens that a strand (or conductor) breaks after being laid down, when the length of cable is considerable and has a fairly high inductive capacity, the fracture can be located, presuming that it is well insulated from earth, by comparing the capacity of a similar sound strand, or conductor, with the broken one, and taking *pro rata* lengths.

The author was once called upon to locate such a broken conductor in a five-cored pilot about 1¼ miles long. There was no intermediate point at which access could be obtained to the cable, and therefore the only thing left was to test from the end. Capacity test located within 20 feet of the fracture, which, under the circumstances, was a good result. But the "discord buzzar" localisation method is also applicable to faults of this class when sufficient capacity current can be obtained.

A word as to the nature of faults which may be expected. In the lead covering of cables there is a probability of impurity, usually zinc, giving a brittle spot which is liable to fracture during laying. The lead is also liable to mechanical damage. Then, with the impregnated cables, the substance used may, by impurities, affect the lead. The author has found lead pitted on the inside more than once. Further, the strands may be buckled, either by twisting during laying or in manufacture, and the insulation pierced and lead fractured. With "drawn in" systems there is a very great probability of damage ensuing from rough handling while drawing in. Faults may also occur subsequently by the weight of the cable resting on a sharp edge either to a draw box or at a pipe joint.

Apart from the necessity of complying with the Board of Trade Regulations as to the electrical connection of all metallic coverings, prudence directs that it should be done, seeing that with high tension cables drawn in short isolated lengths of iron piping, and not otherwise metallically covered and connected, there is considerable risk of sparking through.

The great enemy of all impregnated cables is damp, and the utmost care should be taken during laying, and afterwards at the boxes, to prevent access of moisture.

In the matter of the connection of cables to boxes, the author prefers, in the case of lead covered ones, to wipe joint the lead covering on to the box. This answers two purposes. First, we obtain a good electrical connection; second, we prevent moisture creeping along the cable into the box. Compound glands are more in favour now, principally on the score of cheapness, but the author does not like them. In the first place the electrical connection of the lead to box is not good, and although this may appear a small matter, it becomes serious when there is an earth on the cable near it, the probability being that arcing will take place at the gland and burn the lead, leaving an aperture for access of moisture, and when you find this happen, do not blame the jointer, blame the system. In the second place, compound glands do not make a satisfactory and lasting watertight joint.

One other cause of faults, and by no means the least, is chemical action. The author refers more particularly to the external action between the cable and the soil in which it is laid. Again, there is the electrolytic action between lead and iron, where lead covered cables are drawn in iron piping to which water has access—more especially sea water, or water containing free acid in solution.

The chemical stability of certain insulating compounds is also a point which requires investigation.

The duties of the mains electrician, distribution engineer, or whatever else we choose to call him, have hitherto been far too lightly considered. To be at all fitted for the post, he must combine within himself the engineer, electrician and chemist. He must have an intimate knowledge of the exact position of all his cables, boxes and joints. He must know the weakness of the particular class of mains he is in charge of, the characteristics of his jointers, the state of the weather when any one joint was made, or any length of cable laid. Further, if his cables are buried direct in the earth, or if water containing the soluble matter of the soil can get access to them, he must know the chemical composition of the particular soils with which he has to deal, and their probable effect on the cable under static and electrolytic conditions.

It is not to the laboratory, nor even to the cable factory, that we must look for the information necessary for the construction of the long looked for perfect cable, but to the practical investigations, under working conditions, of the qualified mains engineer.

THE MEETING OF THE TRAMWAYS INSTITUTE.

The annual general meeting of this Institute was held on the morning of Thursday last, at the Frascati Restaurant, only a comparatively small number of members being present at the outset, but the attendance increased before the meeting closed.

Usual business of a formal nature took up the first part of the meeting. The yearly report and accounts were read and passed, with comments by the President, Mr. John Fell, upon the various items of interest. A debit balance exists against the Institute, but this is due to praiseworthy efforts during the past year by the Council to promote the interests of the Institute in the way of printing and issuing its quarterly journal or record of tramway matters.

If opinions are to be asked from outside, or are considered worth offering, one would be tempted to say that still more would have to be spent in this direction for adequate results to follow; but that the Institute would do far better (until it is in a stronger and more influential position) to drop all such outlay, and allow one or other of the established technical or trade journals to be its authorised representative, publishing the various papers, &c., that are brought before the Institute.

It is only when Institutes reach the position of those embracing the Civil, the Mechanical, or the Electrical Engineers, that they are properly justified in publishing more or less elaborate *Proceedings*; even then the cost, though cut down to a minimum, eats a considerable hole in the revenues, being more or less unproductive.

Failing this, the Institute should make up its mind to spend hundreds where it now spends pounds, and issue such a well-printed, well illustrated, and well written journal as shall be a credit to the Institute, and of great service to its subscribers. Half measures in this sort of thing are useless; it is throwing good money after bad.

The President for last year (Mr. John Fell) has done the Institute such yeoman service, that his re-election has followed as a matter of course; the Council, moreover, has strengthened his hand by recommending for election to its ranks such well-known men as Messrs. T. Parker, E. Garcke, S. Sellon, J. H. Rosenthal, H. Graham Harris, J. E. Waller, and E. Pritchard.

In thanking the members for his re-election, Mr. Fell only justified his acceptance by saying that the work of developing the Institute started in conjunction with those who took office last year was not

yet finished, otherwise he strongly preferred an annual president. He also referred briefly to the relations between tramway companies and municipalities, advising the former to insist on having their just rights in view of the unfavourable position they now occupy. Tramway leases—just like electric lighting orders—should be for 42 years, not 21 or less.

Mr. Fell occupies probably a unique position: he is a great municipal man, having thrice filled the mayoralty of Leamington; he is a tramway company director, and a tramway contractor. Doubtless on occasion he has acted as consultant, also a supplier of tramway material, so that there are probably no aspects of tramway work that he has not looked upon.

After concluding the formal business of the meeting, Mr. Stephen Sellon was called upon to read a paper dealing with "Light Railways," but having met with an accident, apologies were offered by him for want of time in the preparation of such a paper as he desired. We therefore give only a brief abstract, embodying such points as are of real interest.

"Through the courtesy of the Board of Trade in 1894 your late President and myself were permitted to listen whilst statesmen and railway magnates tried to define the words 'Light Railways;' and as they failed, I do not intend to try; beyond expressing my opinion that our American cousins in the words 'Street Railways,' adopt a nomenclature which requires no definition.

"For the purposes of this paper I include, under the head of 'Light Railways,' any railway or tramway in a street or road.

"You are all familiar with the word 'Tramway,' and have tasted the sweets of the 1870 Tramway Act, an Act as insulting to the intelligent mind as it is unjust to the investor. But if this can be said of the 1870 Act, what shall I say of the Tramway Act, 1897? Not heard of it? Oh yes you have. I refer to the Tramways Act, 1870, plus all the numerous protective and insolent clauses demanded at the present day by town clerks under the advice of their parliamentary agents who crowd in penalties upon penalties on the top of conditions which, if it does not ruin the undertaking, goes far towards making the words in the preamble of the Bill a mockery, namely, 'that the same will be for the public benefit.' If the 1870 Tramway Act is unjust, it is the agent on the one side and the irresponsible promoter on the other, that have made it so. 'Get an order, workable if you can, but get it,' is the motto of the latter.

"To those among my audience who have not of late years had much to do with the promotion of tramways, it may be interesting to them to know that in addition to the conditions of the Tramway Act, 1870, wayleaves are now generally demanded, a percentuge of the profits after payment of a certain dividend, extra width of road to be paved, the engineer's specification to be supplied to the borough engineers who are to be paid by the promoters to see that the former does not vary from it, abolishment of the arbitration of the Board of Trade; and although the promoters have to maintain their permanent way, the materials to be to the approval of the borough engineers.

"A case has lately come under my notice in respect to a small tramway I am constructing under a set of clauses issued as proper protective clauses for a corporation, in addition to the clauses in the Tramway Act. The borough engineer has a resident who is paid by the promoters, everything has to be done to his orders, though no responsibility is incurred, approximate levels are given to work to but are not guaranteed as correct. The paving has to be made to a template, and a variation in regularity of surface of more than $\frac{1}{4}$th of an inch is condemned. Hard wood paving to be laid opposite all churches and chapels and 50 yards on each side; and it is considered the proper thing to float the granite paving after laying with half an inch of asphalte and finish off with granite screenings, and this construction is considered reasonable for a small town of 40,000 inhabitants with macadamised roads. This is only an illustration of the public spirited way in which the promoter is met, and of the senseless demands of an irresponsible and unpractical borough surveyor.

"With these remarks the author passes with much pleasure out of the world of bumbledom to the consideration of the Light Railway Act, and what it may do to improve the present position, for it is now established that an urban tramway comes within the scope of the Light Railway Commissioners.

"In the first place, the once all-important frontager has disappeared.

"The mode of procedure is economical, and is much facilitated by the local inquiry. Consents are not necessary before the inquiry, thus sweeping aside the blackmail and private agreements of the past to obtain them.

"Clauses are considered by the Commissioners and adjusted by them in case of dispute between the parties.

"There is no purchase clause, this being a matter of agreement if demanded.

"It may be interesting to my hearers to know that so far the author has arranged for purchase at the end of 35 years on a valuation as a going concern.

"The settlement of the first draft order was of some difficulty; but having four schemes in the first session, different Parliamentary agents and counsel were consulted by the author, and the result was a model order, which might be well followed by others.

"The author hopes he will be forgiven if, at this stage of his paper he points out what immense service to the tramway interests it would have been had there been at that period a strong representative tramway organisation which could, in the interests of the industry, have appointed a committee of tramway experts to assist in drawing up a model order as a guide for all, such concerted action would have been gladly hailed by promoters, and all clauses and demands from local authorities and others would have been submitted to the committee before acceptance or otherwise.

"It is the author's view that the apathy on the part of the tramway industry in guarding their interests in the past is responsible for many of their difficulties in the present; and it is possible, should this continue, that the Light Railway Act may become as useless a piece of legislation as the 1870 Tramway Act.

"Look at the railway companies; what a power they are in this country; the reason is solely due to organisation, and though they have many conflicting interests which tramways have not, they guard their general interests, and therefore those of their shareholders, sinking their petty differences, and leaving matters of principle to the judgment of the Railways Association.

"Then look at the Tramways Institute, and you find it gallantly struggling against odds, because it appears impossible to make the average tramway director understand the advantages of combination.

"Your secretary can tell you more accurately than I can how much of the £15,000,000 invested capital in tramways is represented by your Institute; but perhaps the best object lesson you can have to prove how far my views are correct, would be not only to know the capital of each tramway company attached, but how much the directors put aside annually for the funds of the Institute, and how much the treasurer has at his disposal for the protection of their common interests if required."

The discussion upon the paper showed much more life than has been usual at the Institute meetings. Perhaps the subject was a little more modern and up to date than such topics as fodder, compressed air, new horse shoes, or car starters; or again it may have been that the men engaged in light railway work are of the more active type as compared with those supervising horse tramways.

Mr. Alfred Dickinson regretted that Mr. Sellon had adopted such a tone towards municipalities and their officers. So far as his experience went he had found it much better to be conciliatory whilst at the same time holding firm to the just rights of the tramway companies.

Mr. Alderman Whittaker (Mayor of Oldham) next spoke, both as a tramway director and a municipal officer. Mr Whittaker is wise enough, however, to act in the dual capacity in different places. He is Mayor of Oldham and chairman of the Southport Tramway Company. His experiences ought to be very useful by-and-by when fresh arrangements for the local tramways have to be made.

Several members present showed somewhat regrettable proofs of not reading the technical papers, by asking whether it was really possible for tramways to be promoted and powers obtained for their construction under the Light Railways Act. Mr. Sellon had only to mention Crewe to satisfy them. There are several others besides.

Mr. Pogson, of Huddersfield, wished to assure Mr. Sellon that there were plenty of borough officials who had no desire to treat tramway companies harshly, and the borough engineer of Wolverhampton re-echoed the same sentiment soon afterwards. Mr. Pogson incidentally let fall an important remark, dealt with elsewhere, to the effect that a 21 years' period is quite inadequate for making enough profit to pay a sinking fund; and he pitied the tramway company or committee that had to do it.

The President interrupted at this point to bring the discussion back to the chief points at issue, naming three as of importance to all, viz., that borough surveyors and other authorities ought not to impose onerous conditions and supply plans, &c., of a defective nature which yet have to be complied with; also that the Institute proposed amongst other things to draw up a standard order which would be of great use in all further extensions; and, lastly, that for mutual benefit a fund for the common good ought to be started so that obnoxious precedents might not be created with poor and struggling companies unable to fight for bare justice.

Mr. Wain desired the Institute to look forward rather than back, The Light Railway Act promised to give no small relief from the absurd restrictions hitherto placed on tramway enterprise. He preferred to define "light railways"—if a definition were sought—in the terms of the Continental expression as "lines of feeble traffic."

Extensions to existing tramway lines can be made under the Light Railways Act, and we should strongly recommend all such extensions to be so arranged in the future. The Board of Trade, Local Government Board, or whichever department of the powers that be, is authorised to take cognisance of the matter, will surely by that time be struck by the absurdity of a tramway system being in part worked under the Tramways Act, and in other parts under the Light Railways Act, with extremely different conditions.

In replying, Mr. Sellon said that his object had been to show up the *unreasonable* borough engineer and the *unreasonable* local authority. There are plenty of the other sort, of course. He emphasised the importance of the Institute coming forward on behalf of the struggling tramway interests that had no great influence, and might be easily bound down by most onerous undertakings. This has already occurred with many tramway systems which obtained powers before the telephone disturbance quarrel was arranged by the joint Parliamentary Committee a few years ago. Many, if not most of these, accepted the clauses offered (if not insisted upon) by the Telephone Company; and the consequence is that they will, in all likelihood, be unable to adopt electric traction for many years, simply because it will mean a ruinous outlay to protect the telephone system, which has since been called upon to protect itself.

With regard to this point, we were under the impression that the decision of the Joint Committee was to be retrospective, but have not referred back, as after all the point is not of great importance. Long before a good many of our tramway systems promise to be ready for conversion, the telephone enterprise of this country may have gone the way of all private monopolies.

After the conclusion of the meeting, the members adjourned to another room for lunch, and in the afternoon were shown over the works of the Waterloo and City Railway.

At 7 o'clock in the evening the annual dinner was held, and a number of invited guests were present, amongst them being Earl Russell, Mr. William Woodall, M.P., and Mr. Atherley Jones, Q.C., M.P. The speech-making was of a good order, brevity being insisted

upon, but proofs that this quality is also the soul of wit were by no means wanting.

In replying for the Houses of Parliament, Messrs. Woodall and Atherley Jones were deservedly appreciated and applauded. The former could not refrain from pointing out how the term "jubilee" has replaced "*fin de siècle*;" also that the last 60 years have seen enormous advances, but nowhere so much as in transportation facilities.

Yet even to-day the congestion of traffic is as great as ever, and in regard to street transit, the means of coping with it have by no means increased proportionately. He congratulated the audience on tramways being essentially an Anglo-Saxon institution; even the word itself has been absorbed into every language where there are lines at work.

Mr. Atherley Jones pursued a lighter vein of oratory, and pretended to trace a direct pedigree of the modern motor car from the Speaker's chariot lately to be seen parading the route to Buckingham Palace. He had, at any rate, to justify some connection between the House of Commons and rapid transit; since 1870 there has been but very little connection, unfortunately. He regretted that more had not been done, but he had striven his little best; all he could do now was to invite the members of the Tramways Institute, their wives, sisters, cousins, and aunts to tea with him on the Terrace!

Mr. Hugh C. Godfray proposed the toast of the "Local Authorities," and assured his audience that when local authorities were suitably approached, they were delightful people to deal with. Mr. Godfray is the solicitor of the North Metropolitan Tramway Company, and therefore has had much to do with arranging the new lease of this system with the London County Council. He therefore knows what he is talking about, for the London County Council numbers amongst its members a good many of what the Yorkshireman would call "kittle cattle;" but he did not enunciate the essentials of a "suitable approach." From what we know of Mr. Godfray, however, we should say that it presents a combination of "*suaviter in modo*" with "*fortiter in re*."

Mr. Alderman Bray responded for this toast. His speech may be summarised thus:—

£60,000 = cost of Plymouth Tramways originally.
4,000 = price they were sold at.
26,000 = further outlay.
12,000 = price given by Corporation.
60,000 = further outlay by Corporation.

Poor tramway companies!

Perhaps we've got the figures mixed up, but it doesn't much matter; the net result is pretty much the same: A 21 years' lease; horse traction; liquidation; purchase by the local authority.

Earl Russell proposed the toast of the Tramways Institute and its president, Mr. Fell replying in suitable terms. This is a democratic country after all, when energetic self-made men (more honour to them) address what Jeames would call the "hupper suckles" as though Burns was not far wrong in saying that "rank is but the guinea stamp."

Other toasts followed, and a selection of music was provided also. We hope to see as the months run by that the Tramways Institute can arrange equally well for regular meetings of a profitable nature with regard to the information given to and by the members, as it can settle the (comparatively speaking) less important details of a dinner, or excursion. A good beginning was made in this way last year at Huddersfield, and doubtless the improvement in the Institute's position and influence will greatly increase with the recent additions to the Council.

ELECTRICAL CENTRAL STATION ECONOMIES.*

By I. H. BABCOCK.

The business of the central station manager is, not only to "keep the wheels moving," but out of the material furnished him to develop results which will pay the investor a fair income upon the capital invested. If he cannot do this, either the enterprise with which he is connected is unworthy of prosecution, or else he is lacking in the skill and ability to utilise the elements of profit which are in the materials placed at his disposal. To throw away products which can be turned to profitable account and made to pay dividends is an evidence of lack of thrift which admits of no palliation. When we come suddenly from darkness into the light of day, we are partially blinded, and this seems to be the case to some extent in the electrical enterprises. There has been a sudden and wonderful development in this line, millions of dollars have been invested, and thousands of our brightest young men have enlisted to conduct the business affairs of these corporations. This development has been so rapid that many seem to be in a sort of maze, and have not yet taken a comprehensive view of the situation that surrounds them. The manager of an electric lighting company who possesses the technical skill to produce the most perfect light and yet has not the business ability to turn his waste products to practical account cannot be said to worthily fill the position he occupies. He must look beyond the mere production of a dazzling light, however pleasant and attractive that may be. In Mr. T. C. Martin's very able paper, read before the National Electric Light Association at Niagara Falls in June, he remarks: "It is as apparently true to-day as when the association was formed that the companies restrict themselves injuriously in their natural and logical advance by remaining mere lighting corporations." By so doing they are only doing business between dusk and daylight, and are standing idle all the rest of the time. Continuous work is necessary for the greatest success. Interest charges go on just the same if machinery and capital are idle more than one-half of the time. Mr. Martin further says: "We are led to believe that the isolated plants are the real backbone of the electrical power industry to-day. Why this is so it is difficult to explain, except on the hypothesis that station current when obtainable often costs too much, and is generally not obtainable." How then can we have continuous work, and how can we supply current at a profit, and yet so cheap that it will be called for in outside power work? I answer, by utilising the by-product of exhaust steam, and making the lighting station a heating and power station as well. This added profit will enable the manager to increase his day work at a lower price. The more day work, the more steam produced, until soon the station is carrying a fair load at a profit during the entire 24 hours. Heat is as a staple an article for eight months of the year as light. This proposition is neither a theory nor an experiment, as some of the more far seeing are doing this already with great success. Many managers sell exhaust steam enough to more than pay all fuel bills at the station. One manager states that while making no money in lighting, he yet pays 8 per cent. dividends on the entire capitalisation for electric and steam plant out of the income from exhaust steam heating. The same thing holds good in street railway work. Resources and liabilities bear the same relation in electrical operations as in any other. The fuel bill at the station creates a liability, but when it evaporates a certain amount of water into steam, that becomes a resource. How shall this be turned to practical account, so as to put the money in the treasury? The engine utilises about 10 per cent. of the steam produced. When the remaining 90 per cent. is allowed to escape into the air it is a waste of resources, and if this policy is carried far enough it leads to insolvency. The gas companies, as competitors in lighting, maintain their ground by selling everything produced that has a value. When the electric light companies do the same thing they will have established themselves more firmly than ever in the field now occupied by them.

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MR. RIX ON THE USE OF COMPRESSED AIR FOR MINING PURPOSES.

By A. L. STEAVENSON.

An article on this subject appeared last month in an American exchange, wherein compressed air and not electricity is made to take first place as a transmitter of power for mining purposes.

The following passage will show how Mr. Rix views the question; he says:—"I claim that compressed air for intermittent work (which is fully 50 per cent. of all work done by motors) has no rival for general economy or utility, and particularly is this true for mining work."

This is rather a comprehensive and large order, and will bear a good deal of qualification, but still the writer of this, who has used compressed air for five and twenty years and seen a large number of plants of a similar kind, feels that there is really a good deal more of truth in it than the world in general has been led to admit.

But when Mr. Rix goes on to say:—"It must always be borne in mind that economy in compressed air depends upon re-heating and then expansion," he discounts to a very large extent indeed, the balance he has put to the credit of compressed air.

He has in view apparently the metalliferous mines of America, where no doubt the re-heating is possible; but it applies to a very small portion of English mining.

In the South Durham and Cleveland Inspection district there was produced last year 29,107.079 tons of coal and stratified ironstone, whilst of other minerals the total tons were only 129,577.

Now so far as the coal mines are concerned, the process of re-heating is practically impossible; no artificial heat can be allowed away from the shaft bottom. The stratified iron mines will, in some cases, permit it, and there the writer has sometimes adopted the system with great advantage; but as the output of the whole ironstone district represents only six out of 30 million tons, if re-heating and expansion are necessary for the economical use of air, its claims upon our consideration are small indeed.

Fortunately, although we cannot reheat the air in the mine, we can by means of Colladon's cooling system remove the sensible heat generated during compression, and so attain to a very fair economy. This, however, owing to a little trouble in making the apparatus for spraying work properly, and a great deal of trouble in understanding the necessity for its adoption, is seldom done.

Those who really wish to study the subject should read "L'Air Comprimé," by Pernolet, and Unwin's excellent work on the "Development and Transmission of Power."

Now with respect to electricity. Mr. Rix has no doubt in view the conditions prevailing in his own locality and his sphere of observation has been limited. Thus he says:—

"It is true that both hoists and pumps may be run by electricity economically, but as yet there has not been produced a rock-drill actuated by electricity which has been a success.

"I am perfectly aware that my statement regarding the failure of electrical rock-drills may be disputed by manufacturers of the so-called article, or by electrical enthusiasts, but notwithstanding all that, I shall maintain my statement true, and it will receive the support of the larger electrical concerns.

The writer of the present article is not a manufacturer of rock drills, but a large user of them, some actuated by compressed air, others by water, and some by electricity, of his own design; and that they are not a failure, may be judged from the fact that whilst working eight hours per day, one of them drilled 462 holes last week, from 4 feet 6 inches to 5 feet deep, and produced 1,375 tons of ironstone, or 229 tons per shift. If ever Mr. Rix should visit this worn-out old country to pick up a wrinkle, as many of his countrymen do, and whom we are always glad to see, he shall have an opportunity of seeing how it is done. No doubt circumstances alter cases, and as the wind requires to be tempered to the shorn lamb, the drill must be made to suit its work.

Neither is the writer an electrical enthusiast, as may be judged from the fact that he is, and has been, many years using hydraulic power and compressed air for the same purpose. He quite agrees with Mr. Rix when he says: "Compressed air has been abused in its use most shamefully, and until recently none of its friends have been able to be seen or heard, so intensely has the world been centred upon the marvellous results of the investigation into electrical phenomena."

But the fact remains that whether we use hydraulic power, compressed air, or electricity, they must be applied, as the eminent painter mixed his colours, with brains.

NEW PATENTS AND ABSTRACTS OF PUBLISHED SPECIFICATIONS.

NEW PATENTS.—1897.

[*Compiled expressly for this journal by* W. P. Thompson & Co., *Electrical Patent Agents, 322, High Holborn, London, W.C., to whom all inquiries should be addressed.*]

16,428. "An improved method of and means for employing electric traction on ropeways, railways, and like means of transit." J. W. White and H. White. Dated July 12th.

16,443. "Improvements in and relating to incandescence electric lamp sockets and holders." H. Bevis and J. Y. Fletcher. Dated July 12th.

16,447. "Improvements in or relating to apparatus for electrically signalling on railways." T. Elliott. Dated July 12th.

16,488. "Improvement in cores for electric machines." G. Westinghouse. (Date applied for under Patents, &c., Act, 1883, Section 103, 20th January, 1897, being date of application in United States.) Dated July 12th.

16,489. "Improvement in fastening means for core plates of electrical machines." E. M. Nolan. (Date applied for under Patents, &c., Act, 1883, Section 103, 20th January, 1897, being date of application in United States.) Dated July 12th.

16,610. "Improvements in electric switches." G. H. Congdon. Dated July 13th.

16,629. "Improvements in raceways for electric conductors." H. E. Newton. (The American Silex Co., United States.) Dated July 13th. (*Complete.*)

16,665. "Improvements in electric batteries." C. Thery. Dated July 13th.

16,718. "Improvements in electrical recording instruments." H. L. Callendar. Dated July 14th.

16,725. "Reflector mounting or holder for electric incandescent lamps." J. Jergle and G. M. C. Wolffhardt. Dated July 14th.

16,728. "An improved device to be used for electrical heating purposes." H. Edmunds. Dated July 14th.

16,764. "A new or improved electro-magnetic cut-off." J. Luhne. Dated July 15th. (*Complete.*)

16,774. "A means of utilising the dynamic energies or inductive force of matter and apparatus connected therewith." H. Sauche. Dated July 15th. (*Complete.*)

16,788. "Improvements in alternating current motors." W. Langdon-Davies. Dated July 15th.

16,797. "Improved controlling apparatus for accumulator batteries." G. J. Erlacher and M. A. Besso. Dated July 15th.

16,816. "Improvements in the construction of secondary batteries." H. Leitner. Dated July 15th.

16,877. "Improvements in automatic railroad switches." C. V. Richey and L. C. Bailey. Dated July 16th. (*Complete.*)

16,887. "Improvements in devices for recording the duration of use of electric currents." C. C. Schumacher and A. G. Zamel. Dated July 16th.

16,919. "Means in connection with cycles for generating electricity." P. Wagner. Dated July 17th. (*Complete.*)

16,942. "An electric furnace for the application of polyphase currents in processes of fusion on decomposition by means of the voltaic arc." C. Bertolus. Dated July 17th. (*Complete*).

16,967. "Improvements in telephones and telephonic systems." F. Oprender and A. Sarkany. Dated July 17th. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

[*Copies of any of these Specifications may be obtained of* Messrs. W. P. Thompson & Co., 322, High Holborn, W.C., *price, post free,* 8½*d.* (*in stamps*).]

1896.

21,560. "Improvements in tandem-parallel controllers for induction motors." The British Thompson-Houston Co., Ltd. (W. B. Potter and F. E. Case.) Dated September 29th, 1896. The invention relates to the regulation of alternating current motors of the induction type. The controller is arranged so that if either of the motors become disabled for any reason it is cut out without affecting the operation of the other. The special object of the invention being to provide cut-out switches by which this operation may be effected by means of the controller. 5 claims.

23,556. "An improved electrical wire joint or connection." J. B. Melhuish. Dated October 23rd, 1896. The wire joint is provided with two or more openings or holes for inserting the wires and a central slot in which molten solder is poured to unite the ends of the wires which are held therein by a screw. 2 claims.

29,307. "Improvements in peroxide of manganese and carbon electrodes and in the method of producing the same." A. Heil. Dated December 21st, 1896. Relates to a method of producing peroxide of manganese and carbon electrodes, which consists in reducing these electrodes before use in an electrolyte (that contains chlorine but is free from nitrogen) by the action of an electric current from a separate or external source, and then converting the said electrodes into chlorine compounds by reversing the current. 2 claims.

3,083. "An improved ceiling rose and attachment therefore chiefly applicable for electrical purposes." R. W. Braham. Dated February 11th, 1896. The invention consists of forming a thin groove around the base of a ceiling rose similar to those at present in use. The pulley ring is formed with lugs so arranged that they fit the semi-circular slots formed in the rose for the screws so that the pulley ring can be easily slipped on the base of the ceiling rose and readily adjusted by simply turning the ring attachment to the right or to the left thereby causing the lugs to slide into the groove formed in the base of the ceiling rose. 3 claims.